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ABSTRACT

The book contains 28 papers by a variety of authors who deal with technology and social change in foreign countries. The papers are presented under 13 headings: technology and social change in foreign cultures (two papers), technology and values (two papers), technological and social change in history (one paper), the arts and technology (two papers), technological change and social systems (three papers), political and economic forces in technological change (two papers), moral and ethical aspects of the export of technology (four papers), introduction of engineering techniques in developing countries (three papers), communications and the adoption of technology and social change (one paper), impact of modern medicine and biology in developing nations (two papers), agricultural technology: vanguard of economic development (three papers), technology and the arts in modern Europe (one paper), and induced innovation and agricultural development (one paper). (JR)

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TECHNOLOGY AND SOCIAL CHANGE IN FOREIGN CULTURES

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Sponsored by the

Committee on Technology and Social
Change in Foreign Cultures
Iowa State University
Ames, Iowa 50010

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A Symposium on Technology and Social Change in Foreign Cultures

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U. S. Department of Health, Education and Welfare.

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INTRODUCTION TO THE SERIES

September 7, 1972

TECHNOLOGY AND SOCIAL CHANGE IN FOREIGN CULTURES

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Introduction

Good things often are the products of luck and fortuitous circumstances. This seminar, for example, derived its original impetus from a chance meeting between Dr. Barbara Teters of our Department of Political Science and Dr. Rolf Theen, formerly a staff member here. Dr. Theen suggested that Iowa State had an ideal combination of strengths to support a proposal to the Health, Education, and Welfare Department for a new program in international studies, which somehow had missed our notice. What followed, since we had little more than two weeks before the March 1, 1972, deadline, was a frenetic series of meetings and work sessions, mostly involving Drs. Teters, Martin Ulmer, and A. A. Fouad. Arrangements had to be made with faculty, department heads, deans, and Academic Affairs Vice President George Christensen to document our formal commitment to a program which really was not new, but had a rather diffuse existence in the University. Lights burned steadily through two weekends, and Dr. Fouad personally carried the finished proposals to the post office, just in time for the last collection.

A few weeks later, Dr. Fouad called me and reported in an elated voice that funding had been approved. We later learned that ISU was one of the largest of six universities selected for funding a graduate program. Dr. Fouad rationalized that only a few universities had both the experience and the humility to try to seriously assess whether or not all of the technology we have developed and have had thrust upon our society and cultures has produced positive good.

The number of our faculty members who work every year in Europe, Asia, Africa, or South America has always impressed me. The influence of ISU on technical and social development in foreign cultures has grown with time. We now have the background to analyze past achievements and to predict future results.

This seminar will provide a welcome opportunity to record our experience, along with the wisdom of visiting scholars in international affairs, as a prelude to establishing the interaction of technology and social change as a new discipline for graduate study at Iowa State University.

TECHNOLOGY AROUND THE WORLD: A BLESSING OR A CURSE?

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In a series of symposia devoted to the discussion of technology and social changes in foreign cultures, it seems appropriate that the opening session would outline the range of the discussions to follow, and perhaps make a case for the relevance of the topics to be included. Dr. Bohlen has defined the terms and outlined the relationship between technology and social change. We can now ask whether our concern with the impact of technology on social systems and on foreign cultures is a purely academic question, which should be of concern only to a relatively few specialists, or a major issue, which should be of concern to many?

One can argue that new technologies have been introduced in foreign societies for thousands of years. Change is constantly going on in many societies. In every culture, there is a built-in drive towards continuity, or a conservative attitude, which makes it selective in the innovations it adopts. At the same time, these cultures view technical and economic change as a necessity for survival in a competitive world. If this is the case, why do we see this seemingly sudden concern?

We can cite instances where people adopted improved technical devices which turned out to be detrimental to their culture. One can even invoke now-familiar statements concerning the contemporary confrontation between technology and the arts, and project these arguments into nonindustrialized societies which are being subjected to modern technology. But again, why the sudden concern? What is the urgency? Why do some of us feel that this is one of the main issues of our time? Part of the answer may lie in the relatively new phenomenon of planned change.

In the last few decades, deliberate efforts have been underway to spread new technologies to many parts of the world on a cooperative basis. These efforts are cooperative in the sense that they require mutual cooperation, or at least consent, of the host government and of an agency or institution of a technically advanced country. Many governments, universities, and foundations are involved in this effort.

One of the main features of this process is speed. New technologies, which in the past would have taken decades or generations to be assimilated into a culture (perhaps in a modified form), are being introduced in many societies in a short time. Frequently, money and manpower are used as a substitute for time. Other factors that increase the speed at which new technologies are being introduced are the ever-increasing amount of available technical know-how, which creates new devices capable of affecting material well-being, and the increased use of modern communication media, which enhance the spread of new ideas. Even without accurate statistics, we can compare the time it took coffee to go from the Middle East to Latin America with the time it took penicillin to spread throughout the world.

The speed with which new technologies are introduced does not allow time for proper assimilation of these innovations in the local culture. At times, the natural selective process cannot function. Inevitably, the effect is quite disruptive. While the changes appear to be voluntary, there are many changes which profoundly affect the life of the people, and for which they may not be prepared.

The implications of these changes are serious and widespread. Their impact can be felt on the societies involved; on their cultural values and traits, on their social systems, on their political and economic forces, and finally on their art forms. Also, when a society "accepts" a technological innovation, it is likely to have a profound effect on the people involved in this technology transfer. In addition, the technology itself is frequently affected by this new society. Therefore, the interrelationships between technology and society are complex.

Proper understanding of these interrelationships requires an understanding of the effect of changing historical perspective on man and values, and of the social process and the role of technology in it. It also requires a tolerance for ethical and aesthetic values. In human terms, technology transfer can have a profound effect on the people at the receiving end, as well as on the agents of change. Very often, in the encounter between the people involved in this technological transfer, there is a cultural gap that is not recognized as important by either one of them. For example, people in the East usually glorify repose; their mood is one of reflection and contemplation. A Westerner's attitude is one of change and movement; this is reflected in his concept of progress. This basic difference in attitude emerges in their encounter, frequently causing mutual frustration.

At this point, let me reiterate that, in my opinion, the urgency of the matter arises from the fact that planned changes are being introduced at a swift pace on a global scale. Furthermore, many of us here are directly or indirectly involved in it. I do not subscribe to the idea that technology is bad. Neither do I claim that indiscriminate introduction of technological innovations in developing societies is highly desirable. But I do feel it is time for us to be aware of the complexity of the interaction between science and technology on one hand, and the social and cultural changes on the other. I also agree with those who maintain that the lack of communication between people in the technological disciplines and those in the humanities and the social sciences has left some problems in human relations virtually unexplored. This is a serious deficiency which we in the university should attempt to overcome.

To explore the various aspects of the complex interrelationships involved, a multidimensional view of the problem is needed. This series of symposia will attempt to provide this view. Since the problem spans the boundaries of many disciplines in the social sciences, the basic sciences, and technologies, speakers from all these fields will discuss the different components of this complex subject in the coming sessions. The interdependence of these components will be emphasized in the discussions. Thus, it is hoped that this series will provide a forum for cross-fertilization of ideas concerning this problem.

Finally, since this issue is of concern to both the humanist and the technologist, it is time for those of us who are involved in international programs to ask some difficult questions: Is this activity needed? Will this program have disruptive effects on the people and their society? Are we imposing our values on them? It is my feeling that these questions and many others should be asked more often.

Well, is technology a curse or a blessing? There is no simple answer to this. Each one of us will have to form his judgment as to what the answer should be. It is hoped that an awareness of the issues and problems involved will be helpful in this regard.

TECHNOLOGY AND VALUES

September 14, 1972

TECHNOLOGY AND VALUES

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We have been so frequently told the world is changing rapidly that it may be almost impious to question this piece of current wisdom. But it might be useful to think about the possibility that the world may be changing less rapidly than our ideas about it. Perhaps also, part of the change that is assumed to be taking place may reside in our changing modes of evaluating the world as it is, and as it might be.

Whatever our answers to these outrageous queries may be, it seems evident that "technology" originates and is used and has consequences within the arena of human culture and social action. It does not just come "out of the blue." Machines and gadgets are meaningless and useless physical objects in the absence of the knowledge, skill and motivation required to understand and use them*. The once-popular distinction between material and nonmaterial culture is simplistic and easily becomes misleading. The essence of technology is technique, and there can be a technique for doing anything — space flight, courtship, cost accounting, psychotherapy, computer programming, automobile assembly, committee formation, sociological research, or organizing university symposia. If we have the cultural and social and psychological software we can always replace the physical gadgets;

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*"Technologies are bodies of skills, knowledges, and procedures for making, using, and doing useful things. They are techniques, means for accomplishing recognized purposes."[1]

no amount of hardware is of any help if we lack the necessary knowledge, skill, and desire.

There seems to be a view rather commonly held by writers on the subject of technological change that values change only slowly; technologies, more rapidly. Again, however, the conventional wisdom deserves our skeptical attention. As Sheldon and Moore remind us[2]:

> "There are notions commonly stated to the general effect that values are slow to change and practical techniques relatively fast, but exceptions and clarifications can be adduced to make that formulation either suspect or false."

It certainly seems plain, for example, from Flink's study of the mass adoption of the automobile in the United States that favorable values and expectations "ran ahead" of the technology. By 1910, when the Highland Park plant of Ford was opened, the public already was committed to the automobile; indeed, at first it was disproportionately sold in rural ("traditional") communities, and there were mass expectations of cheap quick transportation that would lead to a social utopia[3].

The relation of technology to society, to social change and to the values that permeate human social behavior has been the object of long and intensive attention, especially in the social sciences, history and the humanities[1]. More recently, physical and biological scientists and engineers have intensified their interest in what it is currently fashionable to call "the interface of technology and society." Most of the discussion appearing in the United States until quite recently has tended to take technology as given and to concentrate upon analyzing its consequences. We are now beginning to see analyses of a more sophisticated and penetrating character which are focused upon the social and cultural conditions from which new technologies do or do not emerge. No longer can we take for granted that new technologies will emerge, or that they will be permitted to be adopted, or that their consequences will be either desirable or desired.

New questioning of the effects of technologies come at a time when "...developments in the social sciences and in technology itself have pointed toward the real possibility of coherent, systematic, and focused study of some of the major socially significant aspects of technology."[1]

It is becoming increasingly clear that to appraise the direct and indirect consequences of particular technologies for social systems and the values involved in those systems, it is essential to have quantitative estimates of: inputs → technology → outputs → society → values. Studies using new and powerful theories and computational methods already are producing important and surprising results. Robert W. Fogel has shown that, contrary to much learned opinion, the economic effects of railroads in the U.S. in the nineteenth century probably were rather slight. William D. Hopper's analysis of farming methods used by a village in India showed quite efficient use of resources — again contrary to much expert opinion — and indicated that the additional investment of usual forms of capital would bring very low returns. The Indian farmer acts "rationally" and his institutions do not prevent him from doing so; his productive limitations lie primarily in available technology, other resources, and external demand conditions[1]. As Robert Holt has convincingly argued, technology is not an independent variable over the long run[4]. Hyami and Ruttan have demonstrated the point in a brilliant, detailed comparative analysis of technological change in American and in Japanese agriculture for the period 1880 to 1960[5]. Both the United States and Japan achieved remarkable growth in agricultural productivity, and in both cases technological change contributed greatly to the increases. In Japan up to the 1940's, the main advances were made by biological and chemical means (fertilizer, plant breeding). In the United States up to the 1940's the major improvements were in mechanical technology. During the period in question, the crucial scarce factor of production in Japan was land, in the United States, labor. In the 1930's and 1940's and after, Japanese agriculture increasingly experienced relative scarcity of labor; in the United States, acreage and production controls, in effect, increased the land constraints. Concurrently, the Japanese turned to greater use of machines — of their own devising; the Americans greatly increased the use of biological and chemical means (plant and animal breeding, hormones, pesticides, fertilizers). These striking patterns were not primarily dictated by spontaneous shifts in the personal interests of scientists and technologists but by changes in public policy and basic economic factors. Thus, in both societies, mechanical innovations came mainly from private firms and associations, whereas biological and chemical innovations were generated for the most part in the public sector — a result that is due to the reward-system and especially the location of opportunities for proprietary capture of benefits from discoveries and inventions[4].

Thus technology may be to a crucial extent an endogamous factor rather than a variable imposed upon or intruded into the social system from "outside."

The considerations briefly reviewed above suggest that in attempting to assess and analyze technology in relation to society, it will be advisable to pay close attention to all of the following:

1. Technical characteristics of the technology;
2. Physical arrangement and sequencing of materials, equipment, procedures, persons, communication networks, etc.;
3. Input-output relations of the technology in use;
4. Immediate economic preconditions and consequences of 2 and 3;
5. Immediate social preconditions and consequences of 2 and 3 and 4[*]; and
6. Wider effects of the consequences upon personalities, social relationships, collectivities, institutions, values, and beliefs.

Clearly this list represents a very large order indeed, and our comments here necessarily will be only illustrative. Similarly, it will not be feasible here to do more than to note the added complexities suggested by the observation that technological change may involve, and usually does involve, the following more or less distinct stages or steps[1]:

1. Invention or discovery, resulting in a new technical possibility;
2. Development: testing and altering to attain workable full-scale plans;

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[*] Note, for example, Merrill's comment[1]: "...it is not to be assumed that the particular patterns of factory size, task composition and subdivision, grouping of tasks into jobs, and work group arrangements involved in production are a direct consequence of the requirements of physical technology."

3. Innovation: usual full-scale use;
4. Diffusion (or "imitation") to additional social units; and
5. Improvements and adaptations to varying conditions.

We should note, for example, that technologies vary in their implications for the scale and structure of societies and other collectivities. On the whole, the technologies developed over the last three centuries seem to have facilitated (1) large and complex social aggregations, (2) centralization of decision-making in these large units, and (3) far-extended the scope of effects. These developments involve (4) heightened interdependence. They imply also (5) increased potential vulnerability to failure or disruption at key points of coordination or sequence. Together these five sets of consequences create enormous and pervasive pressures toward political controls in the economy and toward increased activity in the public sector[6*].

If one wished to deal with only one central key to diagnosis of technological orientations in a social system a plausible candidate would be to look for the positive and negative feedbacks linked to discovery, invention, and diffusion of scientific and technical knowledge. In the United States, technological innovation has been closely linked to economic rewards and penalties. Rapid and massive feedback is built into the system of business enterprises. However, the system is not sensitive to externalities (or, "social costs"), to diffuse and unorganized demands (e.g., the desire to avoid unwanted goods and services; provision of goods and services to the poor).

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[*] However, no social trend continues indefinitely at the same rate in the same direction, and there surely are definite factors that will set limits on these developments.

The positive outcomes (advantages, benefits, rewards) of adopting a new technology consist of any object, event, or condition that persons desire. Outcomes that are desired by some social units include consequences that may be regarded as extremely undesirable by other social units, e.g., effects of heroin, victory in war, dictatorial power, pollution from fast automotive transport. The point is "obvious," but crucial, and often overlooked or ignored.

What have we learned about how new technologies are adopted in social systems? Synoptic reviews of the accumulated studies of diffusion of innovations have pointed to the following conclusions[7]:

1. Those innovations that have been widely adopted have spread from points of origin in waves, giving a "ripple" appearance at the frontier, while areas of early adoption become saturated. The total process usually results in an S-shaped growth curve.
2. Diffusion over long distances is rapid in modern urban societies.
3. Innovations tend to be concentrated in urban centers or other centers of heterogeneity, intensive communication, wealth, power, and symbols of legitimacy.
4. Innovations typically are "cumulative" in the sense that the presence of components or elements facilitates or is necessary for new combinations and modifications. Innovations are rarely, if ever, wholly new.
5. Very few technological problems admit to one and only one solution. Typically, there are several — and often, a great many — ways of doing a desired thing.

6. Even with modern facilities of mass communication, "...the fact is that personal communication between pairs of individuals and direct observation are still the basic instruments for the diffusion of innovation."[7]

7. The probabilities of diffusion decrease rapidly with both physical and social distance between adopters and potential adopters.

   Hägerstrand's studies present data for farming populations in Europe and Asia showing that "...the probabilities of contact decrease at a rate steeper [greater] than the square of the distance."[7]

8. Diffusion may be slowed and finally stopped by:
   (a) encounter with diffusion from another center of an incompatible innovation;
   (b) encounter with a linguistic, national, religious, or other cultural barrier;
   (c) saturation of available opportunities (space, markets, etc.).

This brief review of concepts and data relating to technology has brought us to the point at which we perhaps are ready to consider the relations – note the plural – between technology and attitudes, beliefs and values in the social and cultural context.

We must distinguish between values in the sense of valued objects and values as *criteria of desirability* in terms of which "objects" are evaluated. To know that something is valued does not tell us what standards were implicit in the process of selecting it as valuable or not valuable.

This distinction is crucial in cross-cultural comparisons. The concrete objects of evaluation obviously differ greatly across the great diversity of sociocultural systems: for example, monogamy and polygamy, castes, voluntary associations, and numerous other social structures and relationships[*]. Yet, it is quite possible that diverse objects may be evaluated in terms of a common standard[**] – such as efficiency, moral acceptability (humane considerations, honesty, etc.), aesthetic criteria.

It is possible, even if difficult, to imagine that values would appear in human social behavior in random order and sequence, so that any one particular value would be as likely as any other to combine with or follow the expression of a given value, "x." But this imaginary world in which values would appear as if by random numbers is not the reality we know. Rather values do appear in patterns; there are affinities and orderly sequences among values. Furthermore, values are not found in completely discrete units, which combine in purely additive fashion, like laying one brick upon another. Instead, particular value-standards combine with other values in ways which may modify, often radically, the original meaning of each component. For instance, emphasis upon the worthwhileness of "efficiency" may be linked with values of "individual achievement" and "humanitarianism." The actual meaning of "efficiency" would then change if, instead, it were combined with values of nationalistic superiority and racism, as in Nazi Germany. In short, to some important extent, values are ordered into systems, marked by nonrandom associations among values and by sequences of change and stability that are dictated, in part, by feedback through time. Change does not occur just piece-by-piece but rather through interconnected sets of values.

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[*] "At the social level, the institutionalized patterns of value are 'collective representations' that define the desirable types of social system."[8]

[**] "At the cultural level, social values constitute only part of a wider system of value, since all other classes of objects in the action system must be evaluated too. Values are related to such other components of a cultural system as empirical knowledge, expressive symbol systems, and the constitutive symbolic structures that compose the core of religious systems."[8]

We asserted, without giving any evidence, that values are patterned — subject to ordered arrangement. Is this assertion justified? One useful supporting study is the analysis by Bales and Couch[9]. Starting with hundreds of value-items, these investigators were eventually able to produce an illuminating factor-analysis of some 144 items. They found four major factors — clusters of correlated items — as follows:

I. Acceptance or rejection of authority;
II. Need-determined expression vs value-determined restraint;
III. Acceptance or rejection of equalitarianism; and
IV. Individualism

Examples of items that represent these factors will help to convey their meanings. For acceptance of authority, an illustrative item is: "Obedience and respect for authority are the most important virtues children should learn." Value of expression as against restraint is illustrated by agreement with the statement: "No values can be eternal; the only real values are those that meet the needs of the moment." Acceptance of equalitarianism is illustrated by agreement with the statement, "Everyone should have an equal chance and an equal say." The factor of *individualism* was least well captured by the analysis. An illustrative item was, "To be superior a man must stand alone." (Evidently there are several different major kinds of "individualism," in terms of basic values, e.g., ethical autonomy, uniqueness, self-sufficiency, nonconformity, assertiveness.)

An important point about these findings is that the four factors are by statistical definition uncorrelated with one another. This means that all *possible combinations of the four value-clusters can and do occur*. There are, for instance, expressive authoritarians and restrained-ascetic authoritarians. There are individualistic equalitarians and individualistic elitists. And so on. It is a worthwhile exercise to take a little time to work through for yourself examples of all the combinations.

In my own work on American society, I have found it useful to deal with some fifteen major value-themes that seem to have been of enduring historical importance[10]. They are:

1. Activity and work,
2. Achievement and success,
3. Moral orientation,
4. Humanitarianism,
5. Efficiency and practicality,
6. Science and secular rationality,
7. Material comfort,
8. Progress,
9. Equality,

10. Freedom,

11. Democracy,

12. External conformity,

13. Nationalism and patriotism,

14. Individual personality, and

15. Racism and related group-superiority themes.

Taken as a total set, these complex orientations represent a culture that as a whole has been marked by a tendency to emphasize active mastery rather than passive acceptance of events; an external rather than an inward view of the world; an outlook that perceives society and history as open-ended, not static; a faith in rationalism as opposed to traditionalism; an interest in orderliness; a universalistic rather than a particularistic social ethic; horizontal or equalitarian rather than hierarchical social relationships; and a high evaluation of individual personality rather than of collective identity and responsibility.

Suppose we grossly simplify the problem by dichotomizing as either "acceptance" or "rejection" the distributions of responses to the four value-factors found by Bales and Couch. This operation generates 12 major hypothetical societal types, as illustrated in Table 1.

No cross-cultural studies, to my knowledge, have attempted to use a systematic typology of this kind. The attempt would appear worthwhile for it seems inconceivable that there would not be important differences among these types, as suggested by the "guesses" recorded in the last column. Note, for instance, that among the high-authority types there is only one that is rated "high" on its potential for

Table 1. Twelve major hypothetical societal types.

Modal responses to value patterns (A = accept; 0 = reject)					
Authority	Expressiveness	Equality	Individualism	Characterization of type of community or society	Potential for autonomous innovation of technology
A	A	A	A	Pluralistic democracy; dynamic; tense; unstable	High
A	A	A	0	Expressive; equalitarian; "communal"	Low
A	A	0	0	"Safety-value" autocracy	Low
A	0	0	0	Suppressive autocracy	Low
A	0	0	A	Elitist; unstable power-struggle	Indeterminate
A	0	A	0	Hierarchical; communal; politicized	Low or very high
0	A	0	A	Rapid change; "do your own thing"	High
0	A	A	0	Communal; expressive	Low
0	A	A	A	Expressive "anarchy"	High
0	0	A	A	Rare; instable	Indeterminate
0	0	0	A	Moral-restrained individualism; highly instrumental (Rare)	High
0	0	0	0	Extremely rare; instable. (Inequalitarian, communal, restrained, but anti-authority)	Indeterminate

internally-generated, autonomous innovation of technology, but that three of the low-authority types are judged to have a high capacity for generating technological change.

The two examples of classifications of values just sketched are intended to alert us to the specificity and complexity of value-patterns. Anything like a full empirical analysis of a whole society's value systems is a truly formidable undertaking, especially in view of the great internal diversity that is characteristic of all modern societies. Nevertheless, hypotheses and insights useful for anticipating responses to new technologies may be derived from macro diagnoses. A relevant example is provided by the pattern-variable scheme for classifying major distinctive ways of evaluation of social actions and relationships. (This scheme has been elaborated in numerous works by Talcott Parsons[11].) Dominant social values may define obligatory norms that emphasize:

1. Universalism vs particularism (generalized rules or particular relationships among particular social units);
2. Affectivity vs affective neutrality (restraint or expression of immediate emotional needs);
3. Functional specificity vs functional diffuseness (a narrow or wide range of rights and duties, or specified vs unspecified obligations);
4. Achievement (performance) vs ascription (attributed quality), e.g., rewards based on skilled work vs rewards based on birth in a caste or lineage; and
5. Self-interest vs collectivity-interest, i.e., whether in a case of conflict of interests it is morally proper to give priority to self or the collectivity.

The clustering of particularism, affectivity, diffuseness, ascription, and collectivity-emphasis defines an extreme type of Gemeinschaft or "communal" system. The clustering of universalism, affective restraint (or "neutrality"), specificity, achievement-orientation, and normatively sanctioned self-interest defines an ideal-type of Gesellschaft or "associational" system. Other things being at all equal, it seems evident that the Gemeinschaft clustering is likely to characterize "traditional" systems that resist technological change, or at least are unlikely to be highly innovative. For example, some recent studies, as yet unpublished, of Hawaiian communities indicate that a strong set of diffuse communal-particularistic relationships is maintained. Within these relationships, the governing values emphasize equality, fraternal authority, expressive-consumption rather than instrumental restraint, collective welfare rather than individualistic self-interest or "self-realization." This is not a value-system conducive to rapid adoption of new technology that requires individualistic capital-accumulation and energetic competition.

Also, societies in which communication networks follow ascribed, hierarchical, functionally diffuse, and particularistic relationships have great capacities to resist unwanted innovations. On the other hand, if such societies have a centralized system or authority, they are capable of extremely rapid change throughout the whole system — as the classic case of Japan illustrates. Unless an elite takes the lead, however, the diffuse introduction of a technological innovation often will result in initial adoptions mainly by dis-esteemed or marginal groups and social categories — a process that may stigmatize the innovation and check further diffusion.

Most of the major plans for economic development of new nations since 1945 have been based on similar assumptions: (1) development depends on accelerated capital formation, e.g., 15% or more of the national product invested each year; (2) capital must be used primarily to establish and develop the industrial sector; (3) new technology, especially in large-scale units, should be rapidly introduced. These assumptions imply drastic demands on the political system, and a fourth set of assumptions, accordingly, was often invoked; (4) that development requires national planning through a bureaucratic organization, based up by a stable centralized governmental regime. Experience suggests the possibility that this model may be more successful as a strategy for short-term quantitative growth than as an approach for longer-term structural changes that would alter the future capacities of the whole social system[12]. Alternative approaches would require importantly different value-emphasis, e.g., less elitism and more equality, less central authority and more decentralized consent and innovation, more individualism and less forced-communal conformity, and probably more expressive-consummatory and less instrumental-deferred behavior.

Our assignment in this paper was to discuss the place of values in relation to technology. But let us emphasize as strongly as possible that values constitute only one in a complex set of variables. Note, for instance, that typically — and perhaps inevitably — the major consequences of the introduction of a new technology are not fully predictable. Accordingly, all new technology involves some risk. When the technology is complex or otherwise difficult for potential adopters to understand, and when there is an awareness that major undesired consequences sometimes have emerged from other technologies, some apprehension is likely and is understandable. Initial resistance to a technology that seems wholly desirable in the eyes of its proponents is not necessarily irrational, nor even nonrational.

Success of a technology may be defined as a high degree of effectiveness and efficiency in attaining objectives, without excessive costs in use or consequences. Costs consist of all sacrifices and disadvantages, including externalities.

Some technologies are highly successful in one social or cultural setting but not successful in another or others. Lack of success may arise because:

1. Technology is made available but is not accepted;
2. Technology is accepted but is found by actual use to involve excessively direct costs, in relation to its positive outputs; this result may arise because of (a) technical ineffectiveness, (b) presence of an alternative technology providing a better cost-benefit ratio (efficiency); and
3. Technology is effective and efficient for the purposes at hand, but produces unacceptable external costs, i.e., baneful side-effects.

A technology may have immediate effects that appear to be wholly positive, but major undesired consequences appear after a substantial period. Or, the technology may be initially accepted and then quickly rejected on the basis of early negative consequences, whereas a somewhat longer period of utilization would produce a highly positive net balance.

The benefits or advantages of technology may be distributive or nondistributive, i.e., constituting a scarce and divisible value (money, land, individual prestige) or being a value which all share (national honor, religious salvation, moral probity, justice).

Again, the potential or actual advantages of adopting a new technology may rebound to individuals scattered diffusely through a society, or to any type of social subunit — classes, ethnic groupings, regions, communities, corporations, religious organizations, military forces, political leaders, statuses (women, the elderly, veterans, doctors, teachers, plumbers, etc.).

Almost always a new technology will benefit some social units and deprive or injure others. The impact of its consequences will not be uniform.

Thus, resistance to the adoption of a particular technology or class of technologies may arise from:

1. Vested interests, i.e., established or institutionalized advantages, opportunities, rewards — such as wealth, income, esteem, prestige, safety, enlightenment;
2. (a) Uncertainty concerning positive and negative consequences, in comparison with known advantages and disadvantages of extant technologies;

   (b) Apprehension of negative consequences that appear to be highly unlikely but represent extreme undesirability, e.g., total destruction of the planet Earth;
3. Discounting of potential future rewards in comparison with current outcomes;

4. "Technical" social friction, i.e., extensiveness of interlocking changes, each involving some kind of cost or disadvantage, that will be entailed by use of the new technology;
5. Rejection of implicated violations of accepted beliefs, norms, and values;
6. Lack of knowledge (and skill) adequate to successfully maintain and use the technology;
7. Lack of resources, in relation to competing wants and other allocative pressures;
8. Dissonance between old and new beliefs and values or among the new values and beliefs implicated in the new technology; and
9. "Strategic clustering" (focus, convergence) of negative evaluations and threatened interests at points in the social system at which relatively small sub-populations can exert great power, e.g., elite governmental functionaries, unions of highly skilled workers in crucial industries and occupations, military officers, armed proletariat in the capital city.

Even when a new technology meets with little initial resistance, its later and wide use may turn out to be ineffective. Ineffectiveness of use may arise from:

1. Lack of the knowledge necessary to properly utilize materials, equipment, instruments, and so on;
2. Lack of skill;
3. Lack of adequate supporting facilities, materials, services, training;

4. Lack of facilities and "markets" (outlets) for products;
5. Lack of motivation to use the technology effectively;
6. Lack of cooperation among persons and other social units; or unpredictability and malcoordination;
7. Excessive social interference and social conflict (riots, raids, banditry, sabotage, etc.);
8. Insufficient supply (i.e., excessive cost) of one or more factors of production (e.g., capital, in relation to labor); and
9. Excessive externalities, e.g., pollution, social disruption, political threats.

These inventories of conditions relevant to technological change may appear to represent a truly forbidding complexity. The problems of analysis are indeed complex, and no attempts to ignore that fact of life are likely to have happy outcomes. But I hope you will share my convictions that the complexity is not wholly obdurate, that solid and useful analyses are feasible, and that we can get on with the job of acquiring better understanding of technological and social change as crucial aspects of human life today.

It is beyond question that technology, once adopted, has direct effects on the ordering and expression of values by bringing changes in objectively possible options*. It may also have effects on values by encouraging false beliefs about what is possible, e.g., population limitation may be dis-valued because of a belief that new technology will solve all problems incurred by doubling the world's population every 30-35 years. Technology may also affect values by bringing about awareness of discrepancies between ideals and actualities and between different values themselves, a result apparently important in the uses of mass media in democratic politics.

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*"Specifically, technology appears to lead to value change either by bringing some previously unattainable goal within the realm of choice, or by making some values easier to implement than in the past, that is by changing the costs associated with realizing them."[6]

In reviewing the sometimes bewildering panorama we have just surveyed I have come to believe that many commentaries on value-change (including my own) have underestimated the importance of changes in the cognitive components of value-systems. (By cognitive, I mean beliefs about reality – "what exists" and "how it works".) Of prime importance, I now think, are changes in people's ideas of what is possible. Many social conditions that are accepted or endured without complaint when regarded as fixed necessities, arouse intense discontent and demands for change as soon as they are perceived as open to change. When favorable alternatives are believed, rightly or wrongly, to be available but somehow withheld or blocked-off, the potential for attempts to change the society increases rapidly. In this fact, there is great danger and great promise. The danger lies partly in overestimation of constraints, complexities, and unanticipated consequences. The promise lies in the possibility of greatly reducing unnecessary injustices and stultifying conditions that block the search for humane and creative ways of life.

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TECHNOLOGY AND VALUES

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The last half-dozen years have seen a strong resurgence of interest in values in American academia. Associated with this resurgence has been a growing concern that technological innovations have been inflicted on our society with too little consideration of their long-range effect on our value systems. Today's seminar is concerned with the broad topic of the impact of technology on values, particularly in foreign cultures. Professor Williams has explored this subject from a humanist's viewpoint, and I am to explore it from the viewpoint of science and technology. You should be aware that within my professional field, which is chemistry, professors argue about nearly everything, and that professors in different professional fields of science and technology argue about absolutely everything. Hence, my views are not an expression from a monolithic dogma of science and technology, for none exists. Professor Williams would doubtless make a similar reservation for his own field.

While everybody agrees that values are important, there seems to be much less agreement on how to recognize a value in a given society, and, given criteria for recognition, it still seems hard to select a value system which is characteristic of a society, and to rank these values in some order of significance. Professor Williams has tried to give some criteria for recognition of values, and to apply these criteria to American society in his book American Society[1]. He characterizes values as having a conceptual element, being emotionally charged, serving as criteria by which goals are chosen, being regarded as important, and being regarded as matters of collective welfare by an effective consensus. He proposes ordering dominant values according to the criteria of extensiveness (fraction of population and activities manifesting the value), duration (time persistence of its importance), intensity with which the value is sought or maintained, and prestige of value-carriers.

These criteria for recognition and ranking as to dominance seemed to be criteria that I should be able to apply. Without peeking at the end of the chapter, I tried to list some values of American society, and came up with love, marriage, and having children (not necessarily in that order) as plainly satisfying all criteria for dominant values. I then peeked at the end, and found that I had "bombed;" not one of these was listed. I think (perhaps this is a typical rationalization for an inept student) that Professor Williams was concerned with those values which were peculiarly American, and in this sense, love, marriage, and having children were insufficiently peculiar.

In any event, I learned that a sociologist proceeds much more cautiously than I had proceeded. Professor Williams first lists a set of "value-belief complexes," through which values can be discovered. For American society, these are achievement and success, activity and work, moral orientation, humanitarian mores, efficiency and practicality, progress, material comfort, equality, freedom, external conformity, science and secular rationality, nationalism-patriotism, democracy, individual personality, and racism and related group-superiority themes.

Studying these "value-belief complexes," Professor Williams arrives at the following value patterns for American society, and characterizes them as tentative propositions: Emphasis on active mastery rather than passive acceptance, emphasis on the external world rather than inner experience, an open world view emphasizing change and flux, faith in rationalism as contrasted with traditionalism, emphasis on orderliness rather than ad hoc acceptance of transitory experience, universalism rather than particularism (racism is viewed as a "deviant strain" here), equality rather than hierarchy, and individual personality rather than group identity.

Professor Williams has characterized values as emotionally charged, and indeed I can imagine a sermon on values preached in a revival tent, complete with "yea brothers," stamping of feet, and rolling in the aisles. I suspect that this is because our personal values are more emotional than reasoned, and discussions of values are sufficiently vague to permit us to identify the values of the speaker with our own. Professor Williams' criteria for values and value dominance are probably broad enough to permit most Americans, and probably most people in industrialized cultures, to imagine their individual dominant values included. This is a fine situation for revival meetings, but analysis of group values evidently involves judgments in semantics; do the many individuals valuing God, mother, and country mean the same things by these three words?

Professor Williams leads us through a sequence of evaluation procedures for American society, and the steady decline in emotional charge as we proceed through the sequence is striking. The final value patterns do not sound at all like "Give me liberty or give me death." On the contrary, one might imagine the pattern of "emphasis on active mastery rather than passive acceptance" characterized by a zero to one hundred scale, with zero representing complete passive acceptance of everything by everyone, and one hundred indicating complete active mastery of everything by everyone. Since Americans are supposed to emphasize active mastery, we should make the intermediate scale such that American society gets a number over 50 on this scale, for example 65. A primitive agricultural village might rate 35 on the same scale.

The other American value patterns given by Professor Williams are suitable for scaling in similar manner. The "emotional charge" is completely blunted. I cannot imagine a revival tent packed for a debate over whether American society should be given a rating of 65 or 70 on the "active mastery" value scale. By choosing value patterns described in relatively emotionless language and subject, at least conceptually, to quantitative scaling (i.e., patterns characterized not by "all" or "none" but by a gray intermediate scaling), Professor Williams has moved at least a part of the values problem into a position for rational analysis, and at least this part is subject to analysis of technological impact (for example, we might imagine a given innovation changing the "active mastery" rating from 65 to 60).

It seems important to recognize, however, that the transition from individual values to group values to societal values has made more remote the manner in which an impact on societal value patterns may affect individual feelings of human dignity, quality of life, etc. I don't think we can properly define this aspect out of the problem.

There are several points implicit in Professor Williams' discussion of value patterns which I think bear emphasis. First, he comments that one would expect the American value system to differ appreciably from those of other cultures because of differences in location, physical surroundings, climate, resources, and culture strains. I think technology should have been included and emphasized as a part of the environment in which value systems grow. Second, he comments that American values are under strain; that "basic transformations of man and society are underway and many vital choices of values must be made."

These two points emphasize a relativity in values: First, they are not absolute but spring from a cultural environment, and second (this could be regarded as a corollary to the first point) the cultural environment changes with time. I would again emphasize technology as a principal factor in the changing cultural environment. The notion that "many vital choices of values must be made" in the midst of a presentation strongly flavored by cultural determinism seems peculiar. The question of whether values determine the direction of cultural change or vice versa reminds me of Omar Khayyam's[2] encounter with the room of pots:

> "And strange to tell, among that earthen lot
> Some could articulate, while others not
> And suddenly, one more impatient cried —
> Who is the potter, pray, and who the pot?"

A further point which I think is implicit in Professor Williams' discussion, but insufficiently emphasized, is that value patterns are likely to differ substantially between social strata, and in general, between identifiable social groups within a society. Laborers and capitalists, for example, presumably have different value patterns, or at least it would be surprising if they scored the same on the "active mastery" scale. The persistence of very recognizable political coalitions in the United States may reflect, in part, different judgments as to which party is most likely to achieve goals desired according to a common set of values, but I think it is most likely that different value patterns are involved as well. If this is true, it is insufficient to speak of the impact of technology on values of a society as if these values were monolithic. A technological innovation in a foreign culture may affect values of farmers, priests, and bourgeoisie differently.

A final comment on Professor Williams' point of view concerns his citation of a comment by Linton[3] to the effect that "a simple society with a culture all its own ... enjoys a success in conditioning its members no modern society can expect." Professor Williams cites Linton's remark incident to explaining that he would not expect American society to "have a completely consistent and integrated value-structure." However, I think the implications of Linton's "conditioning" remark deserve more emphasis, even in a study of American society (which Linton surely would not have considered simple).

Thus, Williams comments on advertising as an indicator of values, but his own presentation suggests strongly that "conditioner of values," or perhaps even "creator of values" would be a more appropriate term, particularly in view of the value patterns he has selected as characteristic of American society. Value-belief complexes associated with material comfort, progress, achievement and success (particularly the development recognized long ago by Veblen, and cited specifically by Williams of consumption, rather than simply wealth-acquisition, as a measure of success) have all been extensively conditioned by advertising, in my opinion.

Social power structures condition values in more subtle ways by semantics. Williams cites the development of the Puritan ethic into a "salvation through work" commandment. In the development of the American equality and freedom value patterns, the actual words have been fairly constant over the past two centuries, but their meanings have changed. The Declaration of Independence states "...all men are created equal" and the Fifth Amendment to the U.S. Constitution states "...no person ... shall be deprived of life, liberty or property without due process of law... ." In the legal structure of that period, and long thereafter, "men" and "persons" did not include women, slaves, or American Indians, and so any qualms about their freedom or equality could simply be defined away.

In a perfectly similar manner, qualms about murder, in the sense of deliberately killing another human being, in time of war (by whatever euphemism it may be called) are removed with great social skill by simply defining the enemy out of the human race. One does not kill a person but a "slant-eyed Gook," and the very words used make one think more of a "duck-billed platypus" than of a human being. The idea of manipulating societies by manipulating values tends to offend individual sensitivities, but it obviously goes on. It was brilliantly satirized by Aldous Huxley in "Brave New World"[4] decades ago, and is ably discussed as a good way to obtain a happy and prosperous society by B. F. Skinner in "Beyond Freedom and Dignity."[5]

For a rational discussion of values, I think it is necessary to recognize that values exist in a cultural environment, of which technology is an extremely important part, in the presence of social power structures capable of modifying (manipulating) both value systems and cultural environment to some degree. The impact of technology on values in foreign cultures is, hence, at least tripartite; the critical parts are values, cultural environment, and social power structures.

Some idea of technological modification of cultural environment can be gained from a consideration of electric power consumption in different societies. The 1969 U.S. consumption was 18 kilowatt hours per capita per day. Dr. James Lane[6] has calculated that this corresponds to the energy produced by 200 slaves per capita. Many countries (e.g., Yemen, Afghanistan, and Laos) had per capita power consumptions less than 0.5% of the U.S. value.

In a country with per capita electric power consumption under 0.1 Kwatt hour per day, the inference that few people can be using electric stoves, air conditioners, refrigerators, or even electric lights rates an "Elementary, my dear Watson." The inference that they cannot have much heavy industry, that the people are very unlikely to have automobiles, powered farm vehicles, or an effective mass transportation system is only a little less obvious. The inference that the social systems are village-centered (possibly clan-centered), with interactions between villages or clans quite limited, is also probably valid. From this, it may be further inferred that customs, and even languages of social units separated by very small distances are likely to differ sufficiently that the social units will appear mutually foreign[7].

Turning the exercise around, it is easy to forecast certain changes in customs when a society is industrialized to the point where, using one indicator, its electric power consumption increases from 0.1 to 10 Kwatt hours per capita per day. We expect social units to grow, production to become region or state-centered rather than village-centered, and extended families to disintegrate as people become more mobile. These are long-range forecasts that might take a generation or two to occur. An immediate consequence might well be (as occurred in the Industrial Revolution) extensive unemployment in certain sectors of an economy as mass production displaces individually crafted articles. Major improvements in medicine and sanitation might easily lead to a sharp decrease in the death rate with no compensating decrease in birth rate, causing a sharp population explosion, economic disruption, and famine. This in turn could be expected to affect value patterns regarding contraception, abortion, sterilization, marriage, etc.

Even such innovations as the "Green Revolution," capable of vastly increasing food supplies in societies desperately in need of food, can lead, on first introduction, to increased rather than diminished hunger, for they require techniques of fertilization unfamiliar to the marginal small-plot farmers in underdeveloped countries, and planting cycles not in accord with their customs, superstitions, and in some cases, religious beliefs. A likely consequence of rapid introduction is adoption by larger-scale farmers, depression of prices, ruination of marginal farmers, and their starvation unless institutions providing for their relocation and/or relief are developed.

Major technology entering a developing country will require changes in the rest of the country's economy, and consequently in work patterns, travel habits, and perhaps even diet of its people. These changes will occur in spite of the values existing at the time of introduction. The values themselves will change if the technology takes root. How fast the technology can be introduced without serious disruption of the society depends both on its values at the time of introduction and the rate at which they can be expected to change. A humane policy of technology introduction requires consideration of these factors; the consideration may not be easy and may itself give the impression of inhumanity.

Let me illustrate with a model which is far from unrealistic. Suppose a small agricultural African nation barely produces enough to feed itself. Suppose further, that the mean life expectancy of its people is 30 years, and a main cause of death is sleeping sickness, vectored by the tsetse fly. Suppose that a technique (e.g., pesticide, parasite, or sterile male) becomes available which is capable of eradicating the tsetse fly in this nation. Unless provisions can be made for reducing the birth rate, increasing the agricultural production rate, or importing food, the interests of this nation's people are very likely not served by introduction of this technique, for they presumably will die from starvation at the same rate they had previously died of sleeping sickness, and the latter is probably an easier way to go.

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TECHNOLOGICAL AND SOCIAL CHANGE IN HISTORY

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THE WEAPONS OF THE WEST: MILITARY TECHNOLOGY AND SOCIAL CHANGE IN EAST ASIA DURING THE 19TH CENTURY

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The broad problem of technology and social change usually reduces, in practice, to a question of the impact of Western technology on non-Western or nonindustrialized societies. Posed in this form, the problem assumes a spurious simplicity at the expense of ignoring the social determinants of technological change. Technological change is itself a species of social change, which both affects and is affected by other social changes. The impact of society on technology (social values, for example, as a factor in the acceptance or rejection of innovations) is at least as important as the impact of technology on society[1]. This viewpoint has not affected historians much, even among the relative few who admit technology to their study[2].

Even within the restricted context of technology and social change studied as the impact of Western technology, scholars have paid remarkably little attention to military technology[3]. This is doubly unfortunate. On the one hand, it tends to obscure the uniquely important place of military technology in Western development, something that non-Western observers have seldom failed to notice. Military hardware stands high on the list of what developing nations want from the West[4]. On the other hand, blindness to the role of military technology has tended to distort study of the process of modernization or Westernization. While many have observed the process to begin with the transfer of technology, few have noticed that weapons lead the way for other Western technology.

The purpose of this essay is twofold: to explore some aspects of social systems that affect the reception of technology, and to observe the special role of military technology in opening the process of Westernization. This purpose seems best served by a restricted comparative approach spanning a relatively length period of time. The strikingly divergent responses of China and Japan to Western military technology in the 19th century, and the large historical significance of the results, demand attention. A complete account of Western military technology in East Asia over an entire century is clearly beyond the scope of this essay. Its aim is much more modest: to survey some salient aspects of Chinese and Japanese culture as a context for comparing their reactions to Western military technology during the century.

The Great Tradition

The modern history of contacts between Western Europe and East Asia began in the 16th century, as intrepid Portuguese seaman fought their way into the Indian Ocean and beyond. They first reached China in 1514, Japan in 1543. Even then, the military superiority of the West was striking. The gun-carrying sailing vessel as an engine of war far outclassed anything Westerners met all across the south coasts of Asia[5]. Both China and Japan were quick to see and exploit the value of Western firearms. In Japan, troops equipped along Western lines gave Tokugawa Ieyasu the edge he needed to overthrow his competitors for hegemony of the islands, and by 1600 the Tokugawa Shogunate ruled Japan[6]. China, too, readily adopted the superior firearms of the West in the struggles that culminated in 1644 with the victorious Manchus installed as the new Ch'ing Dynasty[7].

Strong and vigorous central governments in both Japan and China soon brought an end to any major European influence. Despite their superior weapons, Europeans were far too few to challenge the new regimes. Both countries imposed severe restrictions on trade with the West, and both almost totally excluded Westerners from their domains. Never before had either country enjoyed so peaceful and prosperous a time as they did in the 18th century. During those happy years, the "Great Tradition" of East Asia far more profoundly affected the West than the curious scientific and technical achievements of the West affected the East[8].

Until the 15th century or so, even the direction of technical borrowing had been more often westward than eastward[9]. That began to change in the 16th and 17th centuries as a result of the West's scientific revolution[10]. The gap widened in the 18th century as England led the way toward industrialization, and the disparity increased as other Western nations followed suit during the 19th century[11]. When the West once again approached East Asia early in the 19th century, its military edge was clearly even greater than it had been two centuries earlier. The meaning of the advantage, however, was slow to emerge. Only when Western arms came to be wielded in support of demands for trading privileges and unequal treaties did the import of the disparity become clear.

As the 19th century opened, both China and Japan were showing signs of impending change that had little or nothing to do with the intrusive West. In China, the Ch'ing Dynasty was slipping into decline. Corruption, oppressive taxation, unrest in the countryside, and all the other ills that Confucian scholars had long regarded as the symptoms of dynastic decline loomed on every hand. The once-efficient Manchu military system had fallen into decay, and only the most strenuous efforts availed to suppress the relatively minor White Lotus rebellion of the 1790's. The presence of the West, its mounting pressure in the 1820's and 1830's, appeared to Chinese eyes as more an irritant than a threat. In the long history of the Middle Kingdom, danger had always risen on the inner frontiers of Asia, never from the sea[12].

The strains in Japanese society were of a different order. The long Tokugawa peace had brought growing prosperity to the country as productivity increased and commerce thrived. China, too, had made such gains, but Japan did not dilute them as China did with a too rapidly growing population. Still, the realities of a society becoming urban and market-oriented strained the fabric of a political system founded on a feudal base. Japan's ruling elite of warriors, the samurai, had been deprived of any real social function with the imposition of the Tokugawa peace, to which some, like the lords of Satsuma and Choshu, had never been fully reconciled. Nothing suggests, however, that these tensions threatened the Tokugawa Shogunate with imminent collapse, though they clearly portended changes to come[13].

The First Confrontation, 1839-1868

In the mid-19th century, East Asian military technology was much what it had been two centuries before. Gunpowder weapons were limited to matchlocks and cannons patterned on 16th and 17th century European models. Such weapons were, in any case, auxiliary, in the same class as lance and pike. The Manchu bannerman trusted chiefly in his bow, the samurai in his pair of swords. The East's naval technology had declined from its 17th century levels. Tokugawa Japan turned its back on the sea, shutting off what had been a vigorous maritime enterprise with an enforced ban on sea travel. The land-oriented Manchus failed to maintain the naval skills even of their Ming predecessors. What water forces the dynasty had were strictly adjuncts to its armies[14].

In sharp contrast, the West had applied itself to military matters with enormous enthusiasm and success. Among the motives spurring the enterprise that had produced the scientific revolution was the desire to improve gunpowder weapons and ships[15]. By the 19th century, Western military technology was beginning to draw more and more effectively on science to advance at an ever-accelerating rate. The first half of the 19th century witnessed the opening stages of a revolutionary transformation of Western military and naval technology. The smoothbore flintlock musket that equipped European armies in 1800, itself a long step beyond the matchlocks still used in the East, had given way by mid-century to the caplock rifled musket. Beech-loading rifled ordnance, firing explosive shells, had begun to replace the older muzzle-loading smoothbores both on land and at sea[16]. Shell guns were but one aspect of a naval revolution whose most important feature, steam propulsion, was already well established by mid-century[17].

The new weapons of war were much in evidence in the first significant 19th century confrontation between China and the West, the so-called Opium War (1839-42). Small British forces easily brushed aside Chinese defenses to impose the first of the unequal treaties that came to symbolize Western imperialism in East Asia. The humiliation of this defeat triggered scattered Chinese efforts to emulate Western arms. A few, mostly obscure, officials urged the Imperial Court to acquire Western ships and guns in self-defense[18]. Nothing much came of these efforts, largely because other matters seemed far more pressing in Peking than Western trade demands, even when backed up by such undeniably superior military force.

China's internal problems loomed far larger. The traditional signs of dynastic decline included rebellion, and Ch'ing suffered more than its share during the first half of the 19th century. These were, however, a mere prelude to the vast upheaval known as the Taiping Rebellion, starting in 1851 and not finally suppressed until 1864. Perhaps the greatest rebellion in Chinese history, it flared in almost every corner of the country, costing millions of lives and causing untold economic damage. And yet it was only one of four major uprisings, and countless local insurrections, that convulsed China between 1851 and 1873, leaving Imperial officials little time to concern themselves with the Western irritant on the coasts[19].

But the same problems that distracted official attention from the growing threat of Western imperialism enhanced the value of Western arms in Chinese eyes. The central government and its regional officials purchased Western firearms and ordnance, as well as warships, and took the first tentative steps toward setting up Western-style arsenals and shipyards. Forces loyal to Ch'ing increasingly outclassed their internal foes in equipment and organization, a key factor in their ultimate success in putting down the mid-century rebellions[20].

Interest in Western arms had a longer history in Japan, where news of England's easy triumph in the Opium War merely jolted an already widespread concern. Japan's military rulers, both national and local, knew that Western ships and guns could not be resisted by sword-wielding samurai. Largely for that reason, the Tokugawa government bowed to American demands in 1853-1854 that its ports be opened to foreign trade. Tokugawa officials and provincial lords alike had already taken the first steps to acquire the new tools of war for themselves, and these efforts were now intensified[21].

Japan's internal problems were far less cataclysmic than China's, and the conflict that followed Commodore Perry's opening of the country to the West was not the vast upheaval that China suffered. The central issue was how best to deal with the Western threat to Japanese sovereignty. As the Tokugawa regime revealed itself unable to expel the barbarians, those feudal lords who had long been restive under Tokugawa rule were able to mount a successful challenge. In this internal power struggle, both sides purchased and built Western arms to equip new military units organized along Western lines. But accidents of geography favored the dissidents, particularly in the southwestern domains of Satsuma and Choshu, who had easier access to Western weapons and training. Their technologically superior forces, better equipped and better organized, defeated the numerically larger Tokugawa armies and overthrew the regime[22].

In the initial confrontation between West and East during the middle decades of the 19th century, Japan was much more alive to the Western threat than China. National and provincial officials in both countries, however, were quick to see the value of Western arms in meeting their own problems. The use of Western ships and guns aroused no significant resistance in either country, whatever their reaction to other aspects of Western culture. In this first instance, there was little to distinguish the responses of China and Japan. While Japan's military rulers might be more alert to the possible implications of a new military technology, China's scholar-officials had never been loath to borrow military technology from barbarians and so found no reason to reject the new weapons of the West.

The crucial issue, and the point from which Japanese and Chinese responses sharply diverged in the 1860's and later, was how much of Western culture was attached to the hardware. China and Japan came up with different answers.

"Self-Strengthening" Versus Westernization

The military problem that the West posed to China and Japan during the late 19th century was compounded by the still-rapid rate of change in Western military technology. By 1900, muskets had given way to breech-loading repeating rifles, smoothbore artillery had been completely replaced by longer-ranged and quicker-firing rifled ordnance, and machine guns were beginning to transform the nature of war. Changes so great and so rapid left even Western armies in confusion during the late 19th century. The World War of 1914-1918 demonstrated just how deep that confusion ran[23]. For the would-be borrcwer in the East, the problems were magnified. Much the same was true of the continuing naval revolution. Here, too, the pace of change was so rapid that the best ships of one decade were virtually worthless in the next. Screw-propelled steamships carrying ever-heavier armor and increasingly powerful guns presented baffling problems to Western navies, and insoluble dilemmas to those who would compete with them[24].

During the 1860's, both China and Japan entered new historical epochs that have been dubbed restorations: the T'ung Chih Restoration in China and the Meiji Restoration in Japan. The same word, however, masks profoundly different experiences.

The T'ung Chih Restoration in China began in 1861 and had largely run its course by the end of the decade. It was a traditional Chinese response to what was seen as a traditional Chinese problem. Several times before in Chinese history, dynastic decline had been stayed for a while when an unusually gifted ruler had overseen a return to Confucian virtue and a revival of honest government. Mid 19th century China was blessed with no such paragon, but a group of particularly able high officials acting for the Emperor achieved results close enough to the historic pattern to justify the analogy. During the T'ung Chih period, China saw a remarkable renewal of administrative vigor and responsible efforts to deal with the country's overwhelming problems. Rebellion was suppressed, machinery for dealing with the West established, and efforts to repair the country's economy undertaken[25].

Associated with the restoration was a movement carried forward under the slogan of "self-strengthening." Just as in the past China had borrowed the superior military techniques of barbarian tribesmen to maintain its traditional society against encroachment, so now in the 1860's China could borrow the military technology of the West to confound the Western assault. The self-strengthening movement outlasted the Restoration itself, and saw the expanded purchase of Western armaments, as well as the establishment of facilities for manufacturing them, and for training Chinese to build and use them. This new equipment undoubtedly contributed significantly not only to quelling internal rebellion but also to reviving Chinese power in central Asia[26].

Self-strengthening assumed that China could defend its traditional society against the West with Western weapons, that the West's military technology could be detached from Western culture as a whole. That was not so. Western arms might support tradition against traditional foes, but the West was something new. Some Chinese officials came to see, reluctantly, the unbreakable chain that led from firearms and ships to coal mines, iron foundries, and railroads; from military technology to industrialization; from military organization to complete Westernization. But that meant the end of traditional Chinese civilization, and few were willing to push the logic to its end and urge so drastic a course before the close of the 19th century[27].

Self-strengthening did produce some results: The spectacular recovery of Chinese Turkestan in the 1870's and a sharp setback dealt to French forces in Indochina in 1885. As a viable policy, however, self-strengthening foundered on the outcome of the Sino-Japanese war of 1894-1895. Losing to a Western power was perhaps to be expected, but defeat at the hands of upstart Japan was humiliating. That defeat was not chiefly a product of technological backwardness. China's weapons were reasonably up-to-date, in some respects superior to Japan's. But China lacked the military organization required to coordinate, direct, and control its scattered forces. In a deeper sense, China's defeat was rooted in the fundamental error of supposing that 19th century Western military technology could be fitted efficiently into the traditional forms of Confucian society[28].

Japan suffered no such illusion. The Meiji Restoration of 1868 was so named from the presumed return to the Emperor of his former power, usurped in recent centuries by the shogun. The rhetoric of imperial rule and a return to time-honored forms disguised far-reaching changes. The younger samurai who had played key roles in overthrowing the Tokugawa regime assumed control of the government. They were profoundly impressed by the West's military technology and were determined to sustain Japan's independence through its use. But they accepted, as their Chinese counterparts did not, the price of that technology, not only in the demand for a new military system, but also for large-scale industrialization and all it implied[29].

The oligarchy that now ruled Japan in the name of the Emperor recognized the economic underpinnings of Western military power. Arsenals and shipyards, technical schools, and foreign advisors were only the first steps. Full industrialization must follow. This logic was not uniquely Japanese. The beginning of China's industrialization can readily be traced to the same late 19th century military concerns. But while that logic was deeply resented and strongly resisted in China, Japan's new rulers embraced it eagerly and threw the government boldly into the process[30].

Japan clearly began to industrialize for essentially military reasons. Whether this process must inevitably lead to imperialism and war is still open to question, but it certainly did for Japan, and Japan has not been alone. Its war with China for hegemony over Korea in 1894-95 demonstrated the proficiency of its new military forces, and its victory over Russia a decade later confirmed its claim to rank among the Great Powers[31].

China, in the meantime, was left prostrate. Self-strengthening had failed, and the disastrous Boxer uprising at the turn of the century confronted China with a choice that could no longer be evaded. After Japan and the West suppressed the Boxers in 1900, China had either to transform itself or perish. Its answer was first reform, then revolution. From 1900 on, a new spirit moved China to cast off its Confucian heritage and to embark on the road of nationalism and modernization[32].

Technology and Social Change

This survey of Western military technology in China and Japan during the 19th century, sketchy though it is, suggests some tentative observations on studying the problems of technology and social change.

In the first place, technological innovation and social change do not react in only one direction. The impact of technology on society, the effects of introducing new techniques or devices into ongoing social systems, may demand study, but so, too, does the impact of society on technology, the effects of existing social arrangements on the reception accorded a novelty. Both China and Japan were in the midst of major changes when the West appeared on the scene early in the 19th century, changes to which neither the West nor its weapons could have been a party. China was more than ready to grasp the opportunity of using Western arms to deal with its own problems, in which, for the most part, the West's role was peripheral. Other aspects of Western technology, and of Western culture in general, which filled no such urgent need, found a cooler reception. Because technological changes tend to be among the most visible of social changes, they are sometimes assigned a causal significance that may really belong to other factors less easily seen.

Judgments about the success or failure of an introduced technology also present difficulties often ignored. Standards of judgment are seldom explicit, and vary from case to case. How a piece of agricultural machinery is assessed for its impact on society, for example, calls into play quite different criteria than does a weapon. While this may be entirely justified, little effort seems to be directed toward spelling out just what standards are being applied. Much depends on viewpoint, often based on assumptions either hidden or unexamined.

This is true even when the inquiry is limited to military technology. Most evaluations of Chinese and Japanese efforts to cope with Western arms produce the verdict that China failed and Japan succeeded, with Japan's triumph over China in 1894-1895 adduced as the clinching evidence. But if China's central problem was, as most Chinese believed, restoring internal order and preserving an ancient heritage, then the Chinese response was really quite successful through much of the 19th century. Reorganized Chinese armies equipped with Western arms were the decisive factor in shattering the internal rebellions of the 1850's, 1860's, and 1870's, and helped to sustain the old order long after it might otherwise have crumbled.

Much also depends on when judgment is passed. The observer who, in 1895, decided that Japan's adoption of Western military technology had proved a success while China's had not, might have felt less secure in that judgment fifty years later. Studies of technology and social change are often strikingly ahistorical, or so narrowly focused in time as to amount to the same thing. Surely the fate of an innovation has not been settled when the funds for a technology project run out, yet a reading of the record might suggest that that is precisely the assumption that prevails, whether conscious or not.

Chinese and Japanese efforts to cope with Western military technology also imply something about the nature of Western civilization. If success in the adoption of military technology is judged in relation to the ability of the adopter to use it against its originators, then clearly at the start of the 20th century, Japan had succeeded and China had failed. China tried to do no more than adopt the West's weapons themselves, while rejecting most of the military and social systems on which the technology was based. Japan acted as if the superiority of Western military technology rested on, and could not be detached from, Western military institutions and Western society. To use the West's weapons against the West demanded Westernization. Both China and Japan saw that the West could only be resisted with its own weapons, but before 1900 only Japan was willing to pay the price of that resistance.

If this is true, it suggests that military institutions and the technology they generate lie much closer to the heart of Western civilization than we have cared to admit. How else is one to account for that typical path of modernization from military technology through industrialization to Westernization down which China followed Japan, and which others have trod as well?

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TECHNOLOGICAL AND SOCIAL CHANGE IN HISTORY

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When I was asked to participate in this symposium, I was told that I should make some observations on the historical effects of technological changes on social conditions and vice versa, and to discuss the interaction between technological and social change in foreign cultures, primarily in developing countries. I expect that I could go back several centuries and base my talk on a statement made by Dr. Lynn White, Professor of Medieval History at the University of California at Los Angeles, that "The chief glory of the latter Middle Ages was not its cathedrals or its epics or its scholasticism. It was the building, for the first time in history, of a complex civilization which rested not on the backs of sweating slaves or coolies but primarily on non-human power."[1] It has been stated further that "It was the new power engineering, which for the first time in human history started to free man from being the principal source of power, that was most responsible for the change in the ways of human life which began during the Middle Ages."[1] However, not all of history resides in the remote past. You may remember that at our opening symposium two weeks ago, Dean Zaffarano commented that "History is being made every day." I believe therefore that I shall confine my attention to quite recent times and to cases directly related to present-day problems.

The point which I wish to make and develop is that the interacting effects of social conditions and technological change depend greatly on the manner in which the change is introduced, whether by revolution or by evolution, by force or by education. I shall start with the premise that technological change in developing countries is desirable, or perhaps necessary. As a general statement, this is probably true; but perhaps the desirable changes are not always as visualized by an "expert" from the United States or, for example, from West Germany.

I well remember a comment which was made by Dr. John Lagerstrom, who was then our Associate Dean of Engineering, while he was serving as Party Chief on a Ford Foundation project at the National Engineering University in Lima, Peru. He stated that his most difficult task was that of recognizing that it was not necessary to do everything in Peru as it is done in the United States, while at the same time guarding against developing a laissez faire attitude that everything in Peru was satisfactory and that no changes need or should be made. As a matter of fact, in some cases perhaps certain changes are not necessary or even desirable. Dr. Jerome Wiesner, the president of MIT and formerly Special Assistant to President Kennedy for Science and Technology, once made a rather astute observation which is sometimes known as Wiesner's Law, namely, that if it is true that a bulldozer can do the work of 75 men, it is equally true that 75 men can do the work of a bulldozer.

It may be profitable to look at a few specific examples. Several years ago, through an Agency for International Development (AID) project, small electrical generators of between 5 and 20 kilowatts capacity were placed in 14 isolated rural towns in Colombia, ranging in size from about 30 to about 200 households. A study of the socio-economic impacts of this project was later made. It had been assumed "that a technical input of this venture would have a ripple effect and might serve as a prime mover in a dramatic transformation of the communities from a traditional to a modern orientation."[2] It was determined however that "the assumptions ... were ill founded; ... that virtually none of the anticipated results was realized and that the introduction of the new technology had an adverse effect overall."[2] It was indicated that the availability of electrical power increased the villagers' awareness of their poverty without providing any means for improving their economic status. It was concluded further that "This and other studies support a larger body of evidence indicating that random technical inputs are futile as a means of stimulating development unless the social and economic system into which they are inserted has reached a level of development at which it can absorb and utilize the input."[2]

In another AID project, a study was made of the effects which might result from the introduction of small electrical power generators in rural communities in India, Colombia and Peru. It was concluded that "the outstanding contribution electric power can make to economic development is in water pumping for irrigation"[3] and that any other uses "would be feasible only if irrigation constituted the principal demand for power."[3] It was noted further that if "innovation is to be effective it must be accompanied by a considerable amount of supporting activity, e.g., community organizational work by local leaders, development of transportation and communications, requisite technical assistance, implementation of economic measures and policies which permit maximum exploitation of profit incentives, etc."[3] It is worth emphasizing that in this case it was noted that the success of a technological change would depend upon its satisfying a definite, and perhaps critical, local need; namely, the need for water for irrigation.

Turning to a totally different situation, when I was in the Philippines I of course noted the almost universal use of the carabao or water buffalo as the source of power in plowing and cultivating the rice paddies. I occasionally saw large tractors, quite similar to those which we have in Iowa, sloshing around in the paddies and my uninformed conclusion was that the carabao was a much better source of power. I learned later that this conclusion had been verified as far as the relative values of a tractor and a carabao are concerned in the raising of sugar cane under the conditions which exist in the Philippines. It was interesting and encouraging to see also a number of small mechanized implements, somewhat resembling a power lawnmower in overall appearance, which were used in plowing and cultivating the rice paddies. These were quite simple in construction and were guided by hand somewhat like a plow or hand cultivator. These seemed to be much better adapted to the necessary tasks in raising rice and also to the economic status of the Filipino farmer. I was told, however, of an interesting case in which a European manufacturer developed and manufactured a very simple, quite effective and reasonably priced implement of this nature which in its original form was a complete failure. The reason for the failure was that the European manufacturer had built the machine of a size to be handled by Europeans and not by Filipinos, who on the average are small in stature.

The introduction of even technically excellent devices and practices is often fraught with difficulties. In the case of the small mechanized plow/cultivator in the Philippines, the major obstacle found by the manufacturer of one well-designed implement was the extreme difficulty which the farmer has in obtaining the relatively small amount of credit necessary to make the purchase, even when it can be shown that the extra profit resulting from the purchase will almost certainly make the investment sound. A similar situation occurs, for example, in the Andean regions of South America where the farmers often cannot obtain credit for the purchase of fertilizer. The farm implement manufacturer cited above found an interesting situation in a market study which he made in countries in Central Africa where the introduction of small tractors was being considered. Here it was determined that a man's prestige, his status and his social standing depend upon the number of cattle which he owns. The replacement of oxen by tractors therefore simply would not take place. The manufacturer turned his attention to the development of improved implements to be drawn by cattle, to the mutual profit of the African farmer and the manufacturer.

An outstanding example of a successful effort to introduce new technology into a very underdeveloped region is afforded by the Cornell University project at Vicos in the mountainous region about 250 miles northeast of Lima, Peru. An objective of the Cornell project was to bring the Indians of Vicos into the 20th century. This was a very ambitious goal as the Indians were actually living under conditions which have existed in the high Sierra regions of the Andes since the latter part of the sixteenth century. Most of the productive land in these regions is divided into huge agricultural areas known as haciendas. These are owned either by the government or by very wealthy absentee landlords, and are leased for periods of ten years to hacienda managers. The Indians are actually in a condition of servitude and are rented along with the land. The common arrangement is that the Indian must work three days a week for the owner, cultivating his land and tending his herds of cattle and sheep. The Indian receives little or nothing for this service. He is allowed to work the remainder of the week for himself on small plots of poor land. Each Indian, man and woman, is also subject to call for additional work one or two days a week, serving gratis as a house servant, cook, handyman, etc. Some two million Indians live under this feudal system in Peru alone.

In 1952, Cornell University, with the cooperation of the Carnegie Foundation and the government of Peru, was able to sublease the hacienda at Vicos. This included some 35,000 acres located at elevations between 9,000 and 14,000 feet. About 7,000 acres were suitable for cultivation and grazing. The Indian population was 1850, comprising some 300 families. At Vicos the wages received by the Indians for working on the manger's land were 20 centavos, or less than one cent per day.

The first task which Cornell faced was that of obtaining the confidence of the highly suspicious Indians. A Cornell anthropologist, Dr. Allan Holmberg, and his family together with one of his Peruvian graduate students, moved to Vicos and set up housekeeping in a dilapidated adobe building without plumbing or sanitation. He became acquainted with the needs of the people and their modes of life. He paid the back wages which were due the Indians and increased the rate of pay. He abolished the extra days of unpaid service on call. Nevertheless, the Indians remained suspicious.

The principal crop in the Sierra regions of the Andes is potatoes. Cornell was actually fortunate in that a severe potato blight had hit the area and the crop had failed. This gave Dr. Holmberg a timely opportunity to introduce blight resistant seed potatoes, fertilizers, insecticides and more modern methods of planting and cultivation. The first year, however, only seventeen of some 380 farmers would accept any of these new techniques. But at the end of the year, these seventeen farmers' acreages produced twice the normal yield and within another two years, all Indians in Vicos were using the new seed potatoes and new methods and were obtaining yields as much as four times as great as under previous conditions. This was the break-through which led to the acceptance of the specialists from Cornell and to the success of the project at Vicos.

At the beginning of the Vicos project, 98% of the Indians were illiterate. With the backing of two or three Indians who could read and write and with the physical help of other Indians, Dr. Holmberg built a new school house and in six years increased primary school enrollment from 17 to 250. Part of this increase was due to the introduction of a school lunch program whereby the Indian children were provided with one nourishing meal per day. A health center was also built and a medical program established. A major part of the cost of these programs came from Cornell's profits from the operation of the hacienda. These profits were plowed back into the hacienda, rather than being siphoned off into the pockets of the hacienda manager as would normally occur. A climax to the project came in 1957 when the complete direction of the project was transferred from Cornell to the Indians, who operated the hacienda democratically by direct vote of all of its adult citizens. Still later, in 1962 when the Cornell lease expired, the Indians at Vicos were able to purchase the hacienda, aided by a loan from the Peruvian government.

Through the Cornell program, the community of Vicos achieved an economic and social stature far above that of comparable regions and is serving as a model for the development of other communities in Peru. In a report on a somewhat similar project carried on by the United Nations at Otavi, Peru, the director commented on the most striking feature of their successful work. "When we first came to Otavi, the Indians were terrified of us. They fell on their knees and kissed our hands. They could not believe that we had come to help them. But you should see them today ... Coming to meet us now, they walk erect. They look us in the eye and shake us by the hand, eager to tell what they have done lately, what they plan next. No more groveling. They have found out that they are men."[4]

We need to ask why the Vicos project was so successful. I believe that there are several reasons. In the first place, the project was carried out in a "low pressure" manner. There were never more than two United States citizens and two Peruvians involved in the development and administration of the project at any one time. In the second place, these people lived with the Indians and learned first hand of their needs. They developed a rapport with the Indians and earned their confidence and friendship. In the third place, they demonstrated significant results on a small scale in a critical situation, as exemplified by the increased production of potatoes. Finally, they developed the capability of the Indians to make their own decisions, working through their established social systems. In the words of Dr. Holmberg, "I must again stress that only a broad and integrated approach to problems of development made it possible to reach the desired goals of higher standards of living, social respect, and a self-reliant and enlightened community which can eventually take responsibility for the direction of its own affairs as a functioning part of the nation. Under this approach, every effort was made to tackle each problem in terms of understanding and respecting the local culture, the only basis on which lasting changes can be understood by the community as desirable and can be accepted by it ... The Vicos experience indicates so far that dramatic results can be achieved at a relatively small cost. They can be attained, however, only if careful attention is given, not only to the problem of modern techniques, but also to the people and their culture. For this reason, from the very start the Cornell-Peru project has given careful thought to the problem of developing a spirit of independence, responsibility, and leadership in community affairs — a spirit that had never existed before except in the sphere of religious life."[5]

Another approach to the introduction of technological change in less developed countries is through conventional educational institutions. I shall mention briefly some of our experiences in the College of

Engineering in three overseas projects in which we worked cooperatively with engineering schools abroad. Perhaps I should apologize for taking all of these examples from Engineering but that is where I have had first-hand experience. Representatives from the other colleges at Iowa State could give examples which are certainly at least equally as good from their experiences. Our three projects had a number of features in common. In each, the objective was to work toward the improvement of the programs of engineering education offered in schools which were already recognized as good schools. In each case, we worked in collaboration with other schools in this country and in one case Iowa State was the contracting agent on behalf of the group of schools. The three projects were at the National Engineering University in Lima, Peru, at Assiut University in the United Arab Republic and at the University of the Philippines in Quezon City, near Manila. The project in the United Arab Republic was sponsored and financed by AID while the other two were sponsored and financed by the Ford Foundation. The projects were similar in the means employed to develop the educational programs in the overseas schools. In each case, faculty members from this country served as visiting professors in the overseas institution. In addition to teaching classes, they worked with the local faculty in the development of courses, curricula, and research programs and, in most instances, also worked in a consulting capacity on problems of school administration. In each case, young faculty members from the overseas institution came to the United States and studied for advanced degrees and then returned to teach at their own institution. In all the projects, money was available for the purchase of laboratory equipment and for the improvement of the libraries. In some instances we furnished short-term consultants on special problems and we aided in the development of contacts with local industry.

Probably the principal problem which we encountered was that of the retention of the young faculty members who returned to their own institutions after receiving advanced degrees. The extent of this problem varied from school to school. At the University of the Philippines, the returning faculty member was always promoted and received a salary increase immediately upon his return. At the other extreme, in Lima the National Engineering University did not often give adequate recognition to the improved capability of the returning faculty members, and in some instances their salaries were exactly the same as they had been two or three years earlier, before coming to the United States to do graduate work. As a consequence, the problem of retention has been much more severe in Lima than in the Philippines. As a matter of fact, every faculty member from the University of the Philippines who has completed his graduate program in the United States has so far honored his agreement to remain at the University to teach. A related problem is that of retaining the returned faculty member on a full-time basis. In many schools abroad, there is great reliance on part-time faculty who divide their time between the University and industrial employment. While this is not all bad, we feel that the University should be the focal point of interest. This is sometimes difficult to achieve when industrial salaries are literally two or three times as great as university salaries.

Another problem is that of finding visiting professors who are both competent and interested, and whose areas of specialization are those which are needed abroad. They must of course be adaptable to local conditions. We also feel that the overseas university should assign counterpart staff members to work closely with the visiting professors. This often has not been possible, not because of lack of interest but because of the lack of an adequate number of local faculty members.

In developing research programs, we feel that it is necessary to emphasize research which is geared to local needs and which at the same time is sound from the academic point of view. Because of the scarcity of funds, we also try to develop local means of outside support; and this is much more difficult than in the United States, even under present conditions here.

We find weaknesses in the area of long-range planning and in following through on the planning which does occur. These are matters which have caused us concern in all of the projects.

In evaluating the success of the projects, we have felt that they were all worthwhile, even the one in the United Arab Republic which was terminated prematurely in 1967. I am no doubt biased, but I feel that in a less developed country, there are especially critical needs in the areas of agriculture and engineering. I feel that anything that can be done to aid reputable educational institutions in the further development of their academic programs in these and in other relevant fields will in the long run contribute to the development of the country. The introduction of technology through normal educational avenues is evolutionary rather than revolutionary and may be slow, but in my opinion it is an excellent means for the successful introduction of needed technological change with a minimum of adverse social effects.

There is one additional comment which I feel should be made in relationship to technological evolution through education. Strictly in terms of the immediate needs of less developed countries, it may well be that they require more well-trained technicians than PhD's. We have found, however, that because of the prestige of an academic education as compared with a more vocationally oriented education, it is difficult to obtain large numbers of qualified persons to study in the technical institutes. In this respect, the situation abroad is no different than in the United States. In a similar vein, the developing countries almost certainly need more agricultural engineers, civil engineers, industrial engineers and mining engineers than, for example, nuclear scientists or aerospace engineers. Again, it is sometimes difficult to channel a young person's interest into areas which are compatible with the most urgent needs of his country.

Another means for introducing technology in a less developed country is through research programs and again the universities should take, and in many instances are taking, the lead. My personal feeling is that such research should be directly related to the local needs, that most of it should be applied research and that much could even be adaptive research in which technology from developed countries is applied to local needs. There must, however, be a modest amount of supporting basic research if the overall research effort is to be effective. The great virtue in introducing modern technology through research is that the research is done locally in the less developed country and in many instances will encounter fewer difficulties in its local application than if it were imported from abroad. The impetus for the development of research programs in universities overseas often comes through projects such as ours in Peru and in the Philippines.

In summary, my observations on the interaction between technological change and social conditions in less developed countries are that the introduction of technology from abroad should be evolutionary rather than revolutionary, that the new technology should be adapted to local needs and that the introduction of the new technology must take place with proper regard for local conditions, customs and social structures. The project at Vicos, to mention again just one example, shows that under such circumstances modern technology can have a most beneficial impact on social conditions.

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THE ARTS AND TECHNOLOGY

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THE ARTS AND TECHNOLOGY

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Obviously, no one can cover the subject of the relation of the arts to technology in 45 minutes. One has to choose between talking about just one art in depth or discussing the general effect of technology on modern arts. I have chosen the second approach.

A polish wit, Stanislaw Lec, wrote this epigram: "If a cannibal uses a knife and fork, is that progress?" This has traditionally been the attitude of literary people toward technology. A hundred years ago Thoreau put it a little differently. He said, "Inventions are likely to be improved means to unimproved ends." You can see that over the span of 150 years, the usual reaction of the literary person has been a mistrust of the sciences, a suspicion that what is called scientific progress is often not social or esthetic progress at all. Whether that attitude is justified is, of course, something that everyone has to decide for himself. I want to discuss first the general relationship of art and society, and by the term art I mean literature, music, painting, sculpture, architecture and all other arts. And I mean both categories of art: 1) significant art which survives, serious art which attempts to interpret society or man's relation to nature or other philosophical questions, and 2) popular art in the form of The Grateful Dead, the ungrateful listeners of the Grateful Dead, and other variations of "popular culture."

H. L. Mencken once said, "A professor must have a theory as a dog must have fleas." So I will list very briefly a number of theories held by professors explaining the relationship of art to society. All of these theories are convincing, and some of them flatly contradict one another, so if at the end of my summary you remain less than totally convinced, I'm afraid that's an understandable condition. The scientists on this campus can make categorical statements and support them with some degree of objectivity and detachment. We in the arts can't, and we don't really have to apologize for it. When life becomes logical and clear, then the arts will be so, too. Till then you will forgive us for recognizing the chaotic quality of life. Now, I'll mention a few of the theories about the relationship of artists to society.

Theory one has been popularized by Carlyle and Ralph Waldo Emerson although many other people, including Nietzsche, have supported it. This is the theory that the artist imposes himself on society; it doesn't matter what the conditions in society are. The artist is a strong personality, and he does what he has to do regardless of whether the society he lives in is progressive or reactionary, liberal or conservative, blooming or decadent. This is related, of course, to the theory that man makes history; it rejects the concept that society permits the man who comes at the right time to take advantage of history.

A second theory is the reversal of this one. Perhaps the most popular exponents of this theory in literature are the French historian, Taine, and the Russian Marxist philosopher, George Plekhanov. Their view is that society makes the artist; the artist is the product of his time; he responds to the conditions in his society; and he is both limited and encouraged by those special conditions.

Taine, for example, insisted that every artist is the product of his race, his milieu, and the moment in history at which he appeared. Actually, when Taine tried to apply that concept in his history of English literature, he had to admit that Shakespeare and Milton and several other great English writers did not fit this concept. It was a nice theory but it didn't always work. Plekhanov, just before 1920, made these statements: "A healthy art appears only when the artist is in tune with his society. Art for art's sake on the other hand appears when the artist is hostile to his society and, secondly, when the artist sees no hope of changing his society." You might test that theory by applying it to modern artists and see whether they seem to be working in tune with our society or out of phase with it. Plekhanov felt that the artist must contribute to the improvement of the social order; the artist who ignores the new doctrines of social life, which would mean also the new technology, and who knows no reality except his own ego, will find nothing new except new nonsense. "The art of a decadent epoch," said Plekhanov, "must be decadent. This is inevitable."

A third theory comes from Oswald Spengler, the discredited German historian who wrote The Decline of the West and whom no modern historian takes very seriously. Spengler did make a number of statements in his book which seem hard to disprove. We need not accept his total concept about cycles of history, and we may disagree with many of his prejudices, but there are certain things he said about the relationship of art and society which you might consider. Let me summarize those briefly.

Spengler divided the development of every culture into two phases. First, he says, when a culture is young, it goes through a humane organic phase. In the springtime of culture man's powers ripen and the fine arts flourish as a natural expression of his inner life and creativity. Then, says Spengler, comes a second phase: An arrid mechanical phase with life on the downward curve, a phase in which men become calloused and externalized. They are given to organization and to the creation of hardened forms of life. They create a shell of empty custom and habit that prevents any further growth. Spengler forecast that the 20th century would exhibit, in its worst aspects, this second decadent phase and this tendency to emptiness is abetted by Western man's mastery of mechanical inventions. In this final phase, according to Spengler, those who understand their fate will give up lyric poetry in favor of business enterprise and will give up painting and music in favor of engineering. Our engineering friends should savor the wisdom of their career choice.

Theory number four is probably too silly to mention but it is frequently referred to by scholars: Henry Adams' philosophy of history. It amounts to his belief that society is no more or less than a function of physical energy, and human history repeats the tendency of all existence towards an ever-accelerated release of energy: a progression from compact force to force in diffuse complexity. I can't explain that to you, but that is what Henry Adams said.

A fifth theory is one suggested by an Austrian novelist named Robert Musil, who is not as well-known as he should be. In 1913 Musil wrote a novel called The Man Without Qualities and what he had to say is even more applicable and true today. The main character, a man named Ulrick, is a mathematician living in Vienna just before World War I. He is called the man without qualities because he has come to feel that in modern society the intelligent individual lives only in a state of neutrality — his experiences are not truly his own experiences, rather experiences are now detachable from men. They are simply in the air and the account of his life belongs in some statistical report on society. The center of gravity, Ulrick feels, no longer lies in the individual but in the relationship between things and institutions. One of his friends calls him a man without qualities because such men appear by the millions now-a-days. Now much more recently C. P. Snow, in a series of novels about intellectuals and administrators in England, portrayed very much the same kind of man: the intelligent, sensitive, perceptive individual who may have a high place in government or in civil service but who feels he has no real power whatever. Not that any other man has power; responsibilities now are so limited that even the man who, to use a trite example, gives the command to fire the nuclear weapons would not feel personally responsible because his decision would first have been approved by the Joint Chiefs of Staff, who would first have cleared it with someone else. In other words, nobody any more feels that he as an individual can do things, and since he can't, no individual need feel personally responsible for the horrors or the failures of modern war and modern society. Similarly, of course, no individual can feel the gratification for achievements and successes.

Theory six, Erich Fromm, the psychoanalyst, accounts for the selflessness of modern man by the marketing orientation. He says the modern self becomes impersonal whenever it is looked upon as something to be exploited, like a product in the market. And, of course, technology has increased the number of products in the market. The person, says Fromm, is identified only with his economic self, the role that he plays along with the other alienated, economic selves.

I've given you six fairly gloomy philosophies and I thought that I'd round them off by quoting from a recent Gallup pole which indicated in the spring of 1972 that, of the American citizens questioned by Mr. Gallup's pollsters, 75 percent consider themselves happy. So obviously all of these pessimists have not impressed at least 75 percent of the population.

The fact is, every generation must restate the eternal issues and eternal myths in its own terms. Not only our generation but every generation in the past has had to rewrite the basic truths, and the basic falsehoods, in terms that interested its members. You will notice that the classics in literature are never best sellers. Mark Twain defined a classic as a book everybody talks about and nobody reads. And he wasn't exaggerating very much. Most of the great classics are read only because university and high school teachers force students to buy them and to read them. It is not Plato but Playboy which is most popular on every university campus in this country. And I say this not with any degree of shock but simply stating an objective fact, as our scientific colleagues like to do. Similarly, the art of each generation which the masses enjoy is not classical art. You have to drag people to museums. They don't go there on their own. And the music played in the music conservatories is not the music of the top forty on radio or the other popular forms of music. They just don't turn out 12,000 students, with or without marijuana, at the Hilton Auditorium for a Bach recital, but they did in the past year on several occasions for rock concerts. It is not a matter of liking or disliking this condition. This is the popular art of our generation. Andy Warhol rather than da Vinci. The Rolling Stones rather than Brahms. And Hee-Haw rather than Shakespeare. I apologize for that grouping but one has to exaggerate to make one's point.

A recent scholar of popular culture, Professor Loewenthal, makes the very relevant point that not only does the art of each generation meet the needs of that generation, but that the art and the classics of previous generations often lose their validity for subsequent ones. For example, he points out that Gretchen in Faust and Emma in Mme. Bovary and Anna Karenina in Tolstoy's famous novel, when they were written in the 19th century were considered great tragic heroines; today they would be considered neurotic women, silly people who should go out and get jobs or join the women's lib movement to regain their places in society. And this is quite true. We have different values, different standards. Certainly the sexuality symposia prevalent on campuses today indicate that you just can't write the kind of novels today that Thackeray or Dickens wrote in the 19th century.

So every generation has to do that. Art, in our generation and in every preceding one, has never been the product of serenity. It is not peace or balance or harmony that creates art. It is tension and conflict. Sometimes it seems that the artist is in harmony with his times, as the great renaissance painters, for instance. But usually you find that an artist is expressing a personal maladjustment or irritation with society and that he then identifies with some movement in society which is dissatisfied. It has never been difficult in any society to find unhappy movements to identify with. Outside of Central Iowa, there has been no utopia on earth for some time. And so every writer, every painter, can always find elements in society which need improving and he identifies with them. For example, Russia has three contemporary Nobel-prize-winning writers. One, Solzenitsyn, is in conflict with modern communism. A second one, Sholokov, was in conflict with Czarism, the system which preceded communism. When Sholokov wrote about the fight against the Czar and the old system, he wrote marvelous novels. Everything he has written since which has attempted to justify modern communism has been third-rate, superficial and sometimes vicious propaganda. Pasternak achieved his great fame not for his first-rate poetry or criticism, but because Dr. Zhivago was so clearly an indictment of communism that the Western world admired it and gave him the Nobel prize. Great art is always an expression of tension or conflict. Sometimes it is a tension on the part of maladjusted artists, sometimes the tension of a healthy artist who expresses the problems of his society and identifies with them as Solzenitsyn now is doing. But we don't expect serenity, and the fact that modern art is not serene is not a criticism of it. The question about modern art is what heights does it reach? To what extent has modern technology raised the level of art's content? And the answer to that, I would say, is that it hasn't raised it at all. We have great artists and writers in modern times, as individuals. But Picasso would have been a great painter at any time, so would Chagall. The Russians I mentioned would have been great writers under any conditions. I don't think we can give science or technology any credit for the achievements of modern writers and I don't think we should blame science for the general caliber of modern television or popular art.

There is one other question to consider in this general approach. Is there simply a change in degree or in kind in modern society? Some people are saying that technology is simply another step, but Toffler, in his book, Future Shock, with which many of you are familiar, insists that we are creating a wholly new society, not a changed society, not an extended, larger-than-life version of our present society.

Now, a few words about the effects of modern culture, modern literature, modern art on the developing countries of the world. That's the current euphemism: "developing countries." Professor Levi Strauss, the French anthropologist, made this statement: "The developing countries of the world are getting the cultural garbage of the developed countries." What he means is that the worst aspects of our culture are the ones which are most quickly adopted in Asia, in Africa, and in South America, and these aspects of our culture are the ones which immediately proved most popular there. The juke box, coca-cola, the advertising on the sides of the bull rings in Mexico, everywhere the least desirable aspects of Western culture are the most popular. When I lived in Asia I found that the music that people tuned in on their transistor radios was rock and roll. I was once walking in the jungle of Ceylon, miles from any inhabited spot, when I suddenly felt I was having a hallucination. I heard Elvis Presley singing something about a doggie in the window. And then a Ceylonese peon came walking around a tree. He was carrying a transistor radio and he was listening to the product of 2500 years of Asian culture, serenity, wisdom: Elvis Presley with a doggie in the window.

At a recent meeting of the Pen Club in New York there was a session on the writer in the electronic age. Marshall McLuhan and Buckminster Fuller were present. An African delegate to that conference argued that the topic of this conference, The Writer in the Electronic Age, was totally irrelevant because in most parts of the world writers still have difficulty getting paper or light to write by. In many developing countries of the world, writers and artists face the dilemma of maintaining the local tradition while they try to reach a larger audience than their own tribe or province. The local dialect, if they use it authentically, would keep everyone but the local group from being interested in their writing. The local images and metaphors and references, if they used them honestly, would keep the interest of the public limited to that small group. If, however, they aim for national appreciation, they are weakening and diluting and diffusing the specific and concrete thing they have to say. A recent study of Japanese television indicated that the great plays of Japan, Kabuki, the Noh plays, the comic drama of Japan, were shown about 13 percent of the available time for theatre presentation. The rest was modern movies, many made by the Japanese. The most popular program in Japan that year on television, and the most widely circulated television program in the whole world, you will be glad to know, is that product of American high-culture, Bonanza. It appeared in 85 countries and had a weekly audience of over 400 million persons — Shakespeare should do that well.

Remarks about the relationship of science and culture should include a recent parody:

"Twinkle, twinkle little star,
I don't wonder what you are,
For by the spectroscopic ken,
I know that you are hydrogen."

One more parody indicates the literary attitude towards the mysteries of life:

"Nature and nature's laws lay hid in night.
God said, 'Let Newton be' and all was light.
It could not last. The devil shouting, 'Lo,
Let Einstein be,' restored to status quo."

This has been the attitude of writers, painters, artists in general. They have for the last three or four centuries in Western Europe and in the United States opposed science and have generally felt that what science gained was not worth what it lost. Always they pointed out the obvious conclusion that science has not improved morality. It has not improved sensitivity, perception, generosity, or people's spiritual qualities. Now, science should not be blamed for this; nobody else has improved them either. But our subject today is the arts and technology. The inescapable conclusion is that science has not achieved what it had hoped to achieve.

Briefly now I want to talk about not the content of the arts, but the techniques. Here are some of the materials which art now uses (I speak of artists, painters, sculptors, and so on). A recent article in an art magazine listed these objects being used in one art exhibit: Nuts, bolts, ratchets, other instruments of engineering welded on to open work metal structures. And in the field of plastics, Perspex has been widely used. Bakelite polyester resin, aluminum, celotex using latex and water, resin and fragmented glass fiber for sculpture, dental materials, low melting alloys, cement fondue with glass fiber net, collages of Cubism and Dada, paper and cloth stuck on canvas, abstract figures made from wire, glass, sheet metal, combs, cylinders, cogwheels, pistons, and brilliant metal surfaces are all used as artistic materials. Glass painting for cathedral windows has been improved. Formica and enamels are used by artists. One English artist has developed a technique for bronze welted sculpture using British Oxygen Company equipment. Another form of including new materials, kinetic art, can be considered the esthetic embodiment of modernism. Kinetic sculptures or constructions "crawl, whistle, whine, swing, twitch, rock or pulsate." I am quoting here from Toffler's Future Shock. He has a tendency to overstate things. The hologram, using lasers for three-dimensional pictures, points to a whole new form of art which people are beginning to develop. I want to just mention the use of the computer for making music, but Professor Ulmer will have things to say about that.

Now, a brief summary of some of the new art forms for which technology is responsible.

The first, obviously, is the computer and the computer has been used, among other things, to enable scientists and artists to help each other. Some of the things the computer has done are these: to to make drawings; to generate sounds and make music including whole musical compositions; to style and design automobiles, television sets, most commercial products which have basic form. The computer has been used to select color combinations, and, I hate to admit as a professor of English, the computer has been used to select sequences of words to create what they call "poems." Although not too many people in my department will admit that what they concocted were poems, the computers have been used to write poems. Architecture is in the electronic age; McLuhan says in a world of space technology the planet itself has become a human artifact, not a natural habitat, and the architect is going to leave his ivory tower for the control tower. He will abandon the shaping of art in order to program the environment itself as a work of art. And those who have seen our junk yards and garbage heaps know what a work of art we have created. Toffler mentioned something called "plug-in" or "clip-on" architecture:

units which can be moved around from place to place in a city, or from one city to another where whole communities are instantly created or torn apart or added to existing things.

And now I want to list for you a few works of art that mix traditional categories in the techniques they use with modern technology. A man named Howard Jones in Kansas City has created experimental works of art which simultaneously use sound, form, color, time, place, and the shape of environment. This concoction makes a sound but you couldn't call that sound music, as he admits. It was exhibited at the Kansas City Museum of Art, but it is clearly not a work of art. It is a new dimension. In Prague, a couple of years ago, my wife and I went to a theatre where we saw another one of these mixtures. It began as a film. Suddenly the film stopped. In the film a man was jumping off a bridge. The lights went on on the stage and a man landed on the floor of the stage. It was the same man and the same costume that had appeared in the film. The music which had been going on in the film was now picked up by a live orchestra on stage and then a number of girls came in dancing and did a number of interesting things and then they stopped and froze, and the movie picked up again continuing with their actions, but now in a filmed version. There was a number of these variations between the film and life and sound. It was interesting, original, and entertaining. The theatre was full. But what it achieved artistically, I can't say. It didn't seem to me to be any extension of artistic awareness, any contribution esthetically. It was charming, and whimsical, and nothing else.

Another mixture is a group in New York called EAT (experiments in art and technology) which gathers together scientists, engineers, and artists in the hope of promoting collaboration between artists and engineers. They held a series of evenings (Public Theater) at the Armory in New York; the nine evenings were a collaboration between artists, dancers, composers and engineers in which they pooled their knowledge. They also subsidized lectures on such subjects as computer music, television, paper, computer-generated images, sound, honeycomb structure, materials, computer poetry, language, color, lasers and holography. To move on to more original creations in modern technology, a recent performance in New York called Variation Five was an intermedia spectacle with music by John Cage, the dance by Merce Cunningham, a film by Stan Vanderbeck, and electronic materials by Billy Kluver. This performance consisted of the following: the dancers as they moved triggered sound when their movements brought them across the beams of photoelectric cells positioned around the stage. The cells also responded to the light intensities of the film. Obviously, no two performances would be the same since different movements would result in different lights and different sounds being created.

In another modern form of art, Jean Tinguely assembled a machine which carried beer bottles on a belt conveyor which was equipped with an axe that beheaded the bottles. Many people laughed as they watched this; however, when one bottle was inadvertently spared there was a deep sigh of relief in the audience. Now, when you begin identifying with a bottle, you've got problems. I am sure you have all heard of the next example, Jean Tinguely's self-destroying machine which he called Homage to New York. This was an enormous machine that he put together and which was destroyed when it exploded — all of its parts flew apart. It never had any value after that moment.

The next example of modern art is something called "The Happening." You have heard about the "happening." Again, I quote Alvin Toffler from Future Shock: "The impulse towards transcience in art explains the whole development of that most transcient of art works, 'the happening.' Alan Kaprow, who is often credited with originating the happening, explicitly suggested its relationship to the 'throw-away' culture in which we live. 'The Happening,' according to its proponents, is ideally performed once and only once. 'The Happening' is the kleenex tissue of art." That's not all. Professor Richardson of the University of Illinois recently suggested that another form of art experience is the use of drugs, deliberately and intentionally, for the purpose of having a more intense esthetic experience. The possibility of an art form, he says, existing in the penumbra between the visual phenomena of optical illusion and the nonvisual scenery of the dream is suggested by the experience of those who use mescaline, LSD, and related drugs. Prominent in their hallucinations are what would appear to be falsying patterns, checkered, whirled, attenuated configurations. All of these, Richardson suggests, are a new form of artistic experience which the 20th century offers to the happy inhabitants.

Speed reading, I want to say, is not a new form of art and I can't resist making the point that when you begin to learn speed reading, you are moving as far away from art as you can. In speed reading, you learn what the author had to say in a hurry, and you can learn in a hurry that Hamlet managed to get his uncle killed. This is not what made Hamlet a great play. You might also learn in a hurry that Oedipus misbehaved with his mother. This is hardly what has made Sophocles' play survive for 2500 years. To put it another way, a basic aspect of art is the form in which significant content is communicated. And the whole emphasis of modern technology is to ignore that form, to summarize it in a Reader's Digest, and to pretend that wisdom can be communicated in capsule form.

In a different sense than he meant it, Marshall McLuhan is right: the medium is the message. Technology has provided ingenious and extraordinary methods of conveying messages, but the messages themselves are today even more superficial, more ephemeral than in the past. Certainly they are no more wise or profound. The emphasis on the mass audience and on the immediate present has even led some artists to assert that the notion of permanence is passé; the modern artist, they say, should not even try to achieve permanence since the world is changing so quickly that it is impossible to attain a universal and lasting communication.

No generation has ever been able to tell which of its works of art would survive, nor do we know today which modern artists will have an appeal for future audiences. We can be reasonably certain that the ones which survive will do so largely because of their content, not because they have latched on to a technique which is currently popular. Although technology has greatly influenced the form of modern art, it has not improved its content.

MUSIC AND TECHNOLOGY

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Music, it has been said, is more sensitive than its sister arts to changes in the social and intellectual climate of a given period. This is particularly apparent in the 20th century, when modern technology has made music available in almost every part of the globe, to a degree scarcely imaginable a few decades ago. Even the average citizen today is able to hear more music of every conceivable type than was the professional musician less than a quarter of a century ago, and the sheer volume of recorded sound presently available is beyond the absorptive capacities of even the most dedicated listener.

Before looking briefly at the impact of technology on music in developing cultures, it would be well to review the major factors responsible for music's having become one of today's consumer commodities.

Undoubtedly, the development of radio and the advent of modern recording devices were principal forces in the public's becoming deluged with music of all types. Radio stations long ago replaced the aristocracy as a patron of the contemporary musician by paying commissions, fees for performances, founding of orchestras, choirs, etc. Phonograph records introduced jazz into Europe primarily through the disks of Louis Armstrong, Duke Ellington, Sydney Bechet and others.

During the Cold War of the 1950's, broadcasts of the Voice of America resulted in the New York Times headline that the U.S. had "a new secret sonic weapon, 'jazz'," for the dissemination of jazz to the communist countries of eastern Europe, Asia and Africa through programs such as "Music-USA" reached an estimated 30 million listeners nightly and induced a profound change in the listening habits of a generation.

Rapid and efficient means of transportation have made tours of diverse ensembles (from jazz groups to symphony orchestras) a reality. The significance of these developments in the present emergence of Afro-American music as a dominant period in music history has yet to be assessed.

Development of film music in the 20th century opened still another avenue of reaching the masses. Although first developed in the 1920's in France as a mere accompaniment to a story shown on a screen, it was soon adopted by serious composers of many nations: Satie, Honegger and Milhaud in France; Kurt Weill in Germany; Prokofieff in Russia; Benjamin Britten and William Walton in England; and in the U.S., Aaron Copland, Virgil Thomson, and John Cage, to mention but a few.

After World War II, technological advances permitted composers such as Varese to make a complete break with the past and to experiment with electronic media and pitchless sounds. The age of "art of a technological mind," of "music untouched by hand," began to emerge.

In 1948 in France, came the establishment of "musique concrete" (concrete music); sounds of all types, recorded on magnetic tape, then processed, combined, filtered or played backwards at any speed or pitch resulted in a virtually unlimited source of materials for the experimental musician-technologist. Germany pioneered in the development of electronic music with sounds produced by oscillators, then modified and recorded on tape. Interest in this new technique spread rapidly to other parts of Europe (especially Belgium and Italy) and to Japan as well as the United States (Columbia, Illinois, and Brandeis Universities).

Electronic instruments were quick to follow; the Theremin, Trautonium, Ondes Martinot, Novachord, Hammond organ and others, produced new aural phenomena. RCA, in 1955, developed an electronic sound synthesizer installed at Princeton, a device enabling man to synthesize almost total electronic sound. Controlled by a coded input tape, it produced not only sounds of conventional instruments, but entirely new sounds through modifications of the tape by cutting, splicing, superimposing, mixing, or playing backwards. Those who first responded to these new devices were trained musicians who moved toward the new technology. More recently, however, a whole new breed of young technologists, more engineer than artist, have experimented with the new sound hardware.

At the Brussels World's Fair of 1958, a three-track tape of synthetic music (Poeme Electronique by Varese) played through 150 loudspeakers elicited the composer to comment: "I heard my music literally in space for the first time."

Attempts had been made as early as 1957 to exclude the human element almost entirely, not only from performance of music, but from its composition. That year saw the development of the Datatron, a composing electronic computer, which, when fed analyses of 100 hit songs (analyses having been made on the number and types of notes and their arrangements), promptly spewed out, within an hour, more than 4,000 brand new tunes.

In 1960, the giant digital computer "Illiac" at the University of Illinois was used by Hiller in musical compositions. Using tables of probabilities describing a particular musical style (Baroque, Classical, Romantic), or even the style of a particular composer, and with random choice of musical elements all equally probable, melodies could be composed. By 1967, more than 5,000 compositions were known for electronic music. Today, in the 1970's, "computer musicians" are well established in the musical hierarchy, their desires translated into sound through the use of synthesizers, such as the Moog, Synket, etc. Just a year ago last October, the Guggenheim Museum in New York was transformed into an electronic music hall when a young composer, Gino Piserchio, played his compositions on a ten-oscillator Moog synthesizer with 18 loudspeakers placed around the spiral ramps of that museum. (Although an older listener came provided with ear protectors, the predominantly young audience was enthusiastic.)

Perhaps the ultimate in computer music combined with other media in recent times occurred in the late 1960's when a 4-1/2-hr multi-media work was presented in the United States HPSCHD (computerese for "Harpsichord" — the word was shortened to the computer's six-letter limit). Imagine if you will, a composition involving the simultaneous use of 208 computerized tapes, 50 amplifiers, 52 tape machines, 49 films, 6400 slides, eight movie projectors and 64 slide projectors. Entirely new listening concepts are involved. The audience is encouraged to move about freely and the listening experience for any one individual becomes distinctly different from that of another and certainly an experience far removed from that of a conventional hall.

All this electronic music admittedly is still rather experimental. Results may not be entirely encouraging, but the possibilities are limitless.

What can be said of the consequences of this modern technology insofar as the future is concerned? The mass distribution of music makes listening easy, perhaps too easy, with a resultant lack of discrimination on the part of the listener. Newer recording techniques, aimed as they are at perfection at any price, frequently result in "sound mosaics" consisting of flawless bits and pieces of a performance recorded over and over again, taped separately, then spliced together so that the end product, a "perfect product," is a performance unlikely ever to be heard in a concert hall. Are we becoming, as one writer puts it, "musical drunkards whose interests lie only in bottled products?" Composers sometimes reply to the ubiquity of music by making their compositions so difficult that only they appear to understand them. The public frequently finds performances incomprehensible, giving little pleasure or esthetic reward because of the harshness, distortion, and absence of tonality. On the other hand, there are those who see in the new musical technology a source of new types of rhythms and unusual sonorities, bringing even greater diversity to music lovers.

Will computers be our future composers and will music ultimately become merely another branch of technology? With the so-called "emancipation of music from notes" as a result of computer technology during the latter half of this century, will the significance of man be even less than before?

What are the implications of this new technology of music for developing nations? It is probably too early to make an assessment, but the increasing social interaction between artists of the world through rapid transportation and communication may ultimately result, according to some, in a global music culture with the possibility of degradation or even disappearance of the local art. The current fascination of developing cultures with western technology however, may make these developing nations more aware of their own heritage and cause them to make efforts to preserve it. Virgil Thomson, a highly respected American composer and critic, in a recent autobiography, alludes to the problem in a closing chapter of his book with the following:

"...With music becoming a powerful establishment...with Japan's big musical literacy a stimulus to massive consumption in both the native and European styles; and with India rapidly becoming through All-India Radio, a pander to ignorance in every style (not to mention what has been done by radio toward destroying the Arab tradition through broadcasts in the Middle East and North Africa of musical artifacts from Cairo's Tin Pan Alley), the standardization of music everywhere, even when this takes place at a high-taste level, is accompanied by a forced consumption repulsive to any but the untrained ear..."

Judgments, however, are never final. One need only read the fascinating little volume "The Lexicon of Musical Invective (1969): Critical Assaults on Composers Since Beethoven" to realize how quickly criteria for excellence in music become modified in time.

Today's disruptive society, in its attempts to adjust to enormous technological changes in music as well as in other arts, has begun to have its perceptions so jolted by new media and new styles that concern is now expressed, not only by listeners, but by composers themselves, that music has reached a dead end. But so long as the creative impulse continues to exist in man, and so long as he retains his natural power of hearing, music in our technological world will continue to evolve and will remain a dominant influence in the cultural life of all nations.

TECHNOLOGICAL CHANGE AND SOCIAL SYSTEMS

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TECHNOLOGICAL CHANGE AND THE FAMILY

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The impact of technology on a society is usually described in terms of economic growth, GNP, population statistics, world food supply, resource depletion, environmental decay. Overlooked is the fact that industrialization brought about by modern technology has resulted in the first change in family pattern since man evolved as a recognizable species. In the opening address of the Family of the Future Conference held on this campus last year, Dr. John R. Platt startled the group with his statement that the nuclear family is a recent development that emerged in the industrialized countries in the 1920's. Up to that time, man everywhere in the world had lived in some kind of extended family.

Technology has brought many physical comforts to the family in the United States: appliances to free the homemaker from household drudgery, convenient means of warming houses in the winter and cooling them in the summer, instruments for world-wide communication and transportation. At the same time, it has created some new conditions of living that bring distress to the family. To date, we have found no satisfactory way to deal with that distress.

1. It has destroyed the economic viability of the small family farm.
2. It has stripped the rural community of many of its functions. No longer is it a center for education, health care, recreation, shopping.

3. It has uprooted families and forced many of them to move to industrialized centers in search of employment.
4. It has broken the informally extended family into nuclear units which often move to widely dispersed geographic areas.
5. It has enveloped the nuclear family in anonymity in its new setting, and surrounded it with neighbors it does not know and which may have values or mores it does not share.
6. It has imposed too heavy a burden on parents who no longer have other adult family members to share in the guidance of their children and to serve as models of adult behavior.
7. It has forced the development of vast government welfare programs in an attempt to assist families in trouble, families that no longer have access to kinship support groups to which they may turn in time of crisis. In spite of the increasing amounts of money and manpower poured into welfare, this bureaucratic approach has resulted in few success stories.
8. Improved health technology has added to population members at both ends of the age scale. Disease control has made it possible for the survival of most newborn infants, even those that are handicapped. Improved health care also has made it possible for more people to live into old age. Both add an ever increasing proportion of

people who are not contributing to the economy, yet require special services.

We are grateful that improved health care can insure the survival of the new born and prolong the life expectancy of all. At the same time, it must be noted that our society has not yet found how to provide adequately for the guidance of the young in the contemporary setting, nor has it found a way to insure a meaningful life for the aging. In short, the nuclear family is not good for children or old people.

In the United States, these conditions which have adversely affected the family have developed gradually over a period of some fifty years. And, before we have found satisfactory means of coping with their impact on the quality of life, we find ourselves facing the possibility of even more sophisticated biological technology that could result in human engineering. We are told that soon we shall have the capability of programming people according to specifications.

Unfortunately, the importation of western technology into another society for industrial and agricultural development is accompanied by the simultaneous introduction of these conditions which have caused family discontent and disintegration here. The major difference is one of timing; the process now becomes telescoped into a brief period with less opportunity for adjustment that we experienced. We can teach people in another part of the world how to use technology to improve industrial and crop production. We are not yet able to help them learn how to cope with the resulting unemployment and family disintegration because we ourselves lack successful experience to share.

Discouraged by the social problems they see around them, some of our young people are responding by rejecting the materialism resulting from technology. Some of them are recognizing the need for support groups larger than the nuclear family, and are experimenting with new patterns of communal living as they search for some of the values of the old-time extended family.

At the first meeting of this seminar a question was raised concerning the motivation for change in a society. It is my observation that the idea takes root in the minds of government officials, be they dictators or elected by ballot, officials who have been exposed to the fruits of technology as they visited or studied in other countries and who want these same things for their own people. The masses in any society have little concept of what will be introduced or what that introduction will mean in their lives; and, if the government officials understand, they may think the price not too high. (Witness the fiasco last summer when the developing countries refused to be concerned about the environment at the Stockholm conference).

Let me illustrate the impact of technology on family life by speaking of the one country other than the United States that I know best — India. Dr. Douglas Ensminger, for 17 years the Ford Foundation Representative in India and who spent much of his time providing for India the kinds of assistance requested by government officials, recently made the statement that the agricultural technicians who journeyed to that country to teach the farmers how to increase production did so with no concern for what that increased production would do to people. Obviously, improved agricultural technology results in fewer farms, fewer farm workers, rural people driven from the villages into urban areas to add to urban congestion and unemployment. To quote Dr. Ensminger, "We don't need more Calcuttas in the world."

Although the large metropolitan areas have been growing in recent years, the majority of the people of India live in agricultural villages, in communities that may be made up of a few dozen families or of several thousand. Traditionally, it is an extended family with the father at the head and the mother in charge of the household. The sons take their brides to the home of their parents. Children that are born into such an extended family relate to many adults. They have the care and guidance of their aunts, uncles and grandparents as well as their own parents. The aging are cared for within the extended family and respected for their wisdom and the guidance they can offer their offspring. Family ceremonies are of major importance and large expenditures for festivals such as weddings are taken for granted. All family members are expected to give priority to the concerns of the family. Nepotism is a virtue, for one's first duty is to help one's relatives.

When agricultural lands are consolidated and machines are introduced for increased efficiency in farm production, some of the sons are forced off the land and must leave the village. They take their wives and children to the city as they seek employment, and the fragmentation of the extended family begins. Finding a job in the new environment is not easy if one has little formal schooling and none of the skills needed in industry. A few, with secondary education and family or political connections may find paid employment. They may even locate an apartment in which to live. Others may be forced to seek shelter in the urban slums, or even to sleep on the street.

Industries employing people from such backgrounds are confronted with unexpected and sometimes prolonged absenteeism as the newcomers try to maintain family ties by journeying to the home village to participate in family festivals. The continuation of such customs is not compatible with the concept of an efficiently managed industry as introduced by western technicians.

The selection of marriage partners has been considered as important for the welfare of the extended family as for the two individuals involved. So, marriages have been carefully arranged by the families concerned. When the families are broken up with nuclear units living in widely scattered areas, it is difficult to provide the same kind of assistance in arranging marriages, a circumstance which encourages a sudden shift toward the self selection of a mate, an approach for which there is little social history or preparation.

Families moving from the villages to the cities may find themselves without relatives to whom they may turn for counsel and support; and, as a consequence, develop a feeling of alienation and rejection. Out of despair and loneliness and human misery spring fresh outbreaks of crime and violence.

The importation of production technology may raise the quality of living for a few fortunate families in a country that is developing agriculturally and industrially. To others, it may bring a period of disaster.

TECHNOLOGICAL CHANGE AND SOCIAL SYSTEMS: FOCUS ON VOLUNTARY ASSOCIATIONS

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Introduction

One day I expect to learn how to say no when a colleague calls and asks me to assume responsibility for organizing and delivering a paper, however brief that paper is to be. Unfortunately for you and me I had not learned to do this by this summer. Moreover, it has only been since I received the program for this series that I realized that I was one of the few persons, if not indeed the only one, on the seminar series who cannot claim "expertise" in a foreign country, with the possible exception of Canada, which hardly qualifies as an underdeveloped and backward society in the economic sense.

If these handicaps were not enough, there was the additional restriction of time; time to prepare and, more importantly, to present a concise and cogent set of ideas pertinent to the topic. Where should one begin? There is a line in Alice in Wonderland which purports to answer this question with the comment, "I think I shall begin at the beginning." The beginning in this case is overcoming the difficulty in defining one of the central terms included in my topic. That term is voluntary association.

Most of us in the U.S. would be able to identify several organizations which we would assume to be voluntary associations. Similar organizations, sometimes even with similar names, in other countries may turn out not to be voluntary at all. Numerous examples could be cited where youth associations in developing countries are or become direct arms of the government and/or political parties. The choice of membership, i.e., belonging, is virtually nonexistent but is defined, for example, by virtue of being a certain age.

Further reflection suggests that several associations to which many of us belong in the U.S. are not really voluntary in the true sense of the word. Many a parent who belongs, by virtue of having paid his dues, to the PTA would likely argue with the concept that such membership is totally a voluntary choice. Professional associations to which many of us belong are no less a case in point regarding the extent to which they are truly voluntary, especially when membership in some may be a consideration in promotions. The point is, in some societies membership in organizations commonly called voluntary is required by the government. In other instances and countries it may be accomplished by less than subtle social pressure from one's peers who are already among the membership. It might also be noted that associations in developing societies which may have been voluntary at one point of time may evolve into mandatory membership and involuntary participation at another stage in the country's development. Case studies of societies which have progressed through revolutionary stages would support this conclusion, albeit I would not suggest that such a transformation is a central law of development.

In order to make a few comments regarding voluntary associations and the relationship which may exist between such social machinery and the introduction of technology into foreign cultures and resulting social change, it is necessary to select a working definition of voluntary association. Rose[1] defines the voluntary association as a group of people who, "finding they have a certain interest (or purpose) in common, agree to meet and act together in order to try and satisfy that purpose." Rose further sees three important functions of such associations in supporting political democracy. Briefly, these functions are as follows:

1. "Through the voluntary association the citizen can acquire as much power in the community or the nation as his free time, ability, and inclinations permit him to, without actually going into the government service, provided he accepts the competition for power of other like-minded citizens;
2. "Those who thus participate become aware of how processes function in their society...; and
3. "The voluntary associations offer a powerful mechanism of social change..."[1]

In addition it may be helpful to keep in mind a general typology of voluntary associations which has been described by Gordon and Babchuck[2]. Their typology includes three types of voluntary associations. The first type is identified as instrumental. An instrumental association according to Gordon and Babchuck[2] is one which will "...serve as social organizations designed to maintain or to create some normative condition or change." A second type of association is identified as expressive and has a major aim "the immediate gratification of the participants, rather than the pursuit of some goal that occurs subsequently in time and perhaps outside the organization itself."[2] A third type which Gordon and Babchuck suggest is really a combination of the two, i.e., some organizations are reasonably balanced between these two functions and may be referred to as instrument-expressive associations.

For the remainder of this discussion I would like to use the above definition of voluntary associations. The general way of characterizing associations into the three different types will also be helpful in addressing two general questions. The first question concerns the impact of technological introduction on existing associational structures within a foreign culture. The second question concerns the impact of associational structures on the processes of societal development in developing countries.

Impact of Technological Introduction on Associational Structures

A useful discussion of this theme requires brief consideration of the connection between technological introduction and voluntary associational structures. There are many possible connections. Technology is usually aimed at increasing production and productivity in developing countries which will in turn lead to "economic" development. Rostow's[3] "stages" may be used as an example of a theory which postulates unilinear economic development. Such a unilinear theory suggests that the introduction of technology will proceed through progress, overcome backwardness, move through modernization and finally achieve "development." There are, of course other theories of economic development which do not assume a uniform linear development. All of the models conclude that economic development will lead to urbanization of the society.

At this point we can begin to trace the impact of technology on voluntary associations. Urbanization leads to a disruption of the kinship system, which is a kind of generic associational pattern (granted it is ascribed and involuntary). Urbanization further leads to a need for developing voluntary associational structures, particularly in the urban settings, to provide opportunities for migrating people to obtain a kind of social security and social differentiation (or identification). Such a change in the kinship system and the corresponding rise of voluntary associations is documented in many studies of development. A recent observation of this process is the subject of a book entitled *Urbanization of an African Community* by Claude Meillassoux[4]. The study identifies some of the transformations which have occurred in the development of the African country of Meli.

The successful introduction of agricultural technology often requires the development of voluntary associations in the rural area. Examples are cooperatives, credit unions and other associational structures which are necessary to complete the task of production, distribution, and marketing of the increased agricultural production. This kind of voluntary associational activity constitutes a significant portion of the *infrastructure*, which is an "in" term among development economists. To see the importance of such associational structures one has only to compare the kinds of associations that were available to introduce hybrid seed corn in the United States with the kinds of structures that may be initially available for the introduction of similar technology in underdeveloped countries. Even with all of the infrastructure; such as the extension service, credit unions, cooperatives and farm organizations, it took 15 years to get total adoption of that new practice in the U.S. One should keep in mind the assumptions behind the usefulness of associational structures for introducing technology, to wit: literacy in order to read the extension bulletins, directions on fertilizer bags and applications and contracts for credit.

It should be noted that every society does have some form of associational structure. Indeed the distinguishing characteristic between the stages of development in a society may be related to the extent that associational structures are related on the one hand to kinship and religious structures and on the other hand to the processes (education, credit, cooperatives, etc.) related to production of goods and services. In the most underdeveloped societies (in economic terms) we may not find associational structures which have the names, symbols, and slogans which characterize the vast associational structure of the western world, especially the U.S. There are however, almost always, "baptizing, marriage, and burial 'societies'".

Thus the effective introduction of technology in a society may require new associational structures such as those mentioned above. But it also requires initial attempts to work through the kind of structures which are there. Such structures may not meet as a group in any regular fashion, or have a constitution, or bylaws or regular membership dues.

We might also be aware of the parallels between the associational structure among the low income people of the U.S. and the people in the least developed countries. Despite the pervasiveness of voluntary associations in the U.S., the participation by low income people in such associations is relatively low. We can see in the last eight years that the emphasis on low income programs in the U.S. has made a major contribution to developing associational structures among low income people in order that they might participate more effectively in acquiring power and in bringing about social change. Saul Alinsky, believed that organization was the key in changing the condition of the urban low-income residents.

We must remember also, that leadership is present in some form in all social groups. In fact, it may at times be a substitute for organization. But it should also be realized that such leadership is a possible means to developing associational structures, or initiating new structures that are most pertinent to the needs at hand.

Let us now turn our attention to a brief consideration of the possible impact of voluntary associations on social change.

The Impact of Associational Structures on Social Change

Eugene Havens[5] has developed a set of propositions about societal development which makes voluntary associations a necessary condition for societal development to occur. The reasoning, in brief, is as follows:

1. "Development is a social product, thus its attainment depends upon the organization of a society;
2. One of the goals of society is societal development;
3. How organizations are structured is a key variable in assessing the probabilities of goal attainment;
4. Development is enhanced if the opportunity exists for members of a society to voluntarily affiliate with instrumental associations;
5. Regardless of how the means-ends chain leading toward societal development begins (e.g., revolution or tutelary democracy), the chains must converge through the establishment of instrumental voluntary associations if societal development is to occur;

6. Without instrumental voluntary associations there is no way to insure access to positions of authority; and
7. Without access to positions of authority, there is no effective mechanism for limiting the imposition of wills by a minority."

Indeed the means-ends schema which Haven suggests as leading to societal development is difficult to identify. It is part of the dilemma regarding the development of an adequate theory to explain societal development. But some observations by those who participate in the development of foreign cultures strongly suggest that there is a point in the process of societal development at which associational structures may (others, as Havens, would say *must*) become a part of the policy determining process for that society. Some examples may illustrate the point. When a viable social movement continues over a period of time it evolves into organized associational structures. Such a structure may be a political party. It may be a direct arm of the government once a revolution has occurred and the new power structure has emerged. Such structures may even take on the form of mandatory membership within the association and be used by the power structure to control further activities on the part of the citizenry. The evolution may be the several different associations which develop, as in the U.S. Civil Rights movement or the Women's Liberation movement. All of us can recite the list of acronyms and alphabet soup which symbolize such developments.

In many societies one can also observe from contemporary times, as well as the historical, the practice of nationalizing youth associations into a direct arm of the political party and eventually a direct arm of the people controlling the government.

Other examples of associational influence would be inferred from the present discussion about power of special interest groups on legislation at both state and federal levels. These special interest groupings include many voluntary associational structures. Thus when we ask the question about the relationship of technological change to voluntary associations we should be aware that the introduction of technology into a culture may require certain kinds of change and development of associational structures in order to bring about economic development. We should also be aware that at some point in time the role of the associational structures may become one of facilitating certain kinds of development as well as inhibiting other kinds of development, as is the case where special interest groups may exert great pressure to forestall environmental quality legislation and action or the elimination of tax benefits.

Summary

There is a growing area of literature and activity concerned with the role of organization in the development of societies, whether they be characterized as developed or developing. There is also a growing conviction that it is important to consider how we develop as well as what we develop. Within this context the role of voluntary associations, which provide a collective voice to individuals, becomes increasingly important. As voluntary associations proliferate, and who can deny that they have, it introduces as a more urgent consideration the question of coordination and interorganizational relationships.

It became very apparent as I made a superficial review of the literature in order to organize these few comments that there is a great deal of information available at the present time which could be further examined in considering the question of technology, social change, and voluntary associations. It also became apparent that I could not successfully integrate the various streams of thought from these several sources in a brief presentation. As a compromise to this situation I have included a very selective and rather short bibliography that may be of interest to persons concerned with the question of voluntary associations in societal development of foreign cultures. The question of voluntary associations may be quickly transferred into the question of institution building as a part of the development process. I would suggest this topic as being worthy of much further investigation.

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HOW TECHNOLOGY IS RELATED TO FORMAL AND INFORMAL VALUE SYSTEMS - EDUCATION

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It may be helpful to remind ourselves that we tend to interpret education in another country from the standpoint of our personal set of values cherished within our culture.

Our very choice of concerns betrays us, and perhaps, makes us less objective.

> "Education, broadly conceived, is the way a society perpetuates its value system. ...the family is the most important institution for the inculcation of values. But formal education has a particularly important role in the formulation and expression of values. Formal education is often one of the most fundamental media for the expression of these core values."[1]

It should be pointed out that not all values are of equal importance, but the core values are inculcated and reflected in the homes and the schools of both developing and highly developed countries. Values of agricultural life, family loyalty, community pride, personal integrity, and justice are seldom left out in preparing a person for his role in society. The informal and formal education perpetuate the values system with some modification as these values are modified by economic, social and technological forces. The very opportunity for formal education may change family authority. The young person who is able to read may change his attitude toward the importance of sanitation inspite of prevailing practices in the home. Thus, we can observe that formal education can be a disrupting force and lead to questioning of existing values.

Margaret Mead makes this condition explicitly clear:

> "For many years schooling was not only ineffective, but also disruptive, because it was applied only to the young. Roles were reversed in the home, so the children became the teachers of the parents, creating confusion in relationships, and resentment on the part of displaced leaders."[2]

Education in developing countries is still struggling for a system of universal, free primary education. The lack of universal secondary education, and in some regions, even universal elementary education means that formal education has in these regions less impact upon the important role with regard to the formulation and expression of values in such societies.

As a consequence, it is more likely that the values will be more pluralistic in such societies. National cohesiveness may be weaker because of a lack of universal public education.

Many of the developing countries are making concerted efforts in nationalizing education programs and investing a large part of their economy toward the development of their human resources. The problem of quality and quantity of education also poses a dilemma for most developing countries.

There are many functional interrelationships and international implications regarding technology, social sciences and education. Technology should not be interpreted to mean a product resulting from the application of science. Rather we should think of technology as a way of thinking, and a way of organizing the life of society. Frequently we think of technology enabling us to move from human muscle power, to machine power, to serving as attendants of machines, etc. Each technological transition is difficult. The technological, social, and economic benefits to man have achieved for him increased rights of life, freedom and the pursuit of happiness. Technologically advanced countries achieve these goals more efficiently and more broadly for more people as time goes on.

Government agencies in developing countries observe the fruits of technology and the ways technology brings the good life to more people more quickly.

Certain measure of leisure and abundance in the life of an individual is conspicuous in technologically advanced countries while poverty and human struggle continue in developing countries where the masses have little access to education. Education must reflect and express the sociological, economic, and personal values which are possible and attainable for more people if acceptance of technology is based upon the concept of thinking and organizing life for improvement rather than just perpetuating what is. Stated more simply, is there a better way to conserve our water, our land, our air, to reduce hunger, to reduce demoralization of people, to revitalize our villages, to free more people from struggling for survival so they can be educated to become more productive and be able to face change?

A balance of elementary, secondary and higher education is necessary in keeping with the developmental level of the country. At the same time, an access of arts as opposed to science can also be a limiting factor in economic growth and social progress. I personally advocate a balance of general education with technical and professional training for participatory involvement in economic, political and cultural activities.

It is a complex problem to plan education in developing countries. The tendency is to telescope change without recognizing the consequences of the transition. Planners must recognize that is is possible for countries to invest inefficiently in human resource development, that is, to put money in the wrong kind of formal education, to perpetuate the wrong kind of incentives, and to fail to integrate effectively the training with demands brought about by technology. A nation becoming industrialized may demand more engineering and technical education emphasis as opposed to educating the elite for a colonized society.

Developed countries have invested considerable money in education at all levels, general, technical and professional. It is helpful to be reminded that behind every educational decision is a conscious or unconscious value which determines the direction education priorities will take. In our own country, the emphasis on space reflects the American value system.

Behind this investment, is the human hope that benefits will precipitate to all mankind from this investment. Some are less patient than others with the immediacy of the pay off from such an investment. Communication has had a large impact on all countries resulting from our success in space exploration. We know more about the floods, the starvation, the agonies of the battlefield, and the gold medal winners of the olympics as a result of our satellite communications. This technology of communication affects our thoughts, gives rise to new concerns, and makes us more aware of tensions confronting all mankind.

One may be asked, how does education differ for various levels of technologically developed countries? Frederick Harbison, a scholar of comparative education, indicated that each country needs to think out a strategy for the education and development of its human resources.

His observation was stated as follows:

> "The progress of a nation depends on the progress of its people. Unless it develops their spirit and human potentialities, it cannot develop much else materially, economically, politically, or culturally."

He also points out, "education can become socially malignant if its people do not have a chance or incentive to use it."[3]

Harbison provides us with several other insights regarding the development of human resources. He states:

> "It takes skilled human agents to discover and exploit natural resources, to mobilize capital, to develop technology, to produce goods, and to carry on trade. Indeed, if a country is unable to develop its human resources, it cannot build anything else whether it be a modern political system, a sense of national unity, or a prosperous economy."[4]

Thus, we see that the underdeveloped, partially developed, semi-advanced, and advanced countries will have to work out some logical strategy of human resource development through education and training within the context of prevailing economic and political imperatives. If political stability and unity are considered a national concern, very likely the federal government will make concerted efforts toward achieving these imperatives. On the other hand, if a strategy of human resource and manpower development is paramount, an integration of a broad range of educational programs will be supported. Developing nations are aware the investments in education contribute to economic growth, but it is obvious that economic growth makes it possible for nations to invest in educational development. Education, as Harbison points out, "... is both the seed and the flower of economic development. It is apparent that the social and political pressures for more and better education are strong in all modernizing nations."

The availability of mineral wealth, world markets for particular commodities, the population/land ratio, social and cultural traditions, and many other factors are interrelated in increasing education and GNP output of a nation.

We should not be led to believe that education alone can solve the majority of problems facing developing countries. Education frequently lags behind in bringing about needed changes in values to keep pace with changing technology, advancing economy, and political decision-making processes. We also find the education frequently is an illumination rather than a developmental process for upward mobility. This is particularly true in developing countries where universal education is not attained. Education of the elite or fortunate few does provide these individuals with confidence, ability to reason and face change. Education is constantly concerned with and actually seeking answers to most of society's problems — health, food, recreation and human fulfillment.

The experiences of trying to transplant the educational practices and successes into another culture has clearly demonstrated to us the futility of such practices. Experience has taught us, as Margaret Mead suggests: "that change can best be introduced not through central planning, but after a study of local needs."[2] A study of local needs, values, economics and opportunities for benefit to the community will contribute substantially to success. Working through the local leadership, both for the acceptance of the project and for ensuring its continued success is necessary. Demonstration projects followed by educating the villagers frequently is effective particularly where such projects are interpreted against a local background. It appears that people generally want to improve their lot where opportunity and/or tensions exist. Tensions between society's basic values are among the most important in all social dynamics. Education does contribute to tensions in many societal institutions. Education not only aids in shaping our values, but also determines our outlook on life and governs our behavior and expectations in life.

Ferkiss reports that "sociological studies show that religious adherence is possibly the single most important social variable in determining behavior in a variety of situations."[5] My question to this audience is: do you think that education is a close second variable?

In summary then, we would perhaps agree that in all countries, at all levels of development, education has the function to perpetuate and improve the values of the particular culture. I am also equally convinced that we are globally concerned to a greater or lesser degree with the notion of human dignity. I will close my remarks by sharing with you a definition of education by an internationally distinguished scientist which I find acceptable. He stated:

> "Education directs a learners actions, inspires his behavior in all contacts with mankind, and helps him to master himself. It consists in giving him, from the tenderest childhood, the notion of human dignity."[6]

This may be the highest value needed for survival and personal fulfillment in a technologically advanced society.

I thank you.

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POLITICAL AND ECONOMIC FORCES IN TECHNOLOGICAL CHANGE

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POLITICS AND TECHNOLOGICAL CHANGE IN THE NEW STATES

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I will modify the general topic somewhat. Rather than addressing myself to all foreign cultures, I should be content to address myself to the new states. I shall try to remember that one primary goal of the seminar is "to create an awareness of the functional interrelationships and international implications of social sciences, humanities, technologies and sciences in mankind development around the world." The general question today is how does politics in the new states affect technological change? Conversely, what is the impact of technology on politics of the new states?

Our discussions fall into two parts. In the first part, I shall deal very briefly with the traditional societies. Here the salient questions are what is the reaction of traditional political systems to technological change and what does this mean in terms of our concern? I make no claim to originality here. In the second part, I shall address myself at some length, but within the confine of time to the new states.

Here I must insist that we cannot fully understand the relationship between technological change and politics without an understanding of a number of elements:

1. The political leaders of new states;
2. The nature of the environment in which both political leaders and change agents must interact; and

3. The constraints which face political leadership such as the choice and management of technological change.

Alternatively, we could ask a series of questions about technological change and the political sector in the new states. For example, who makes the decision on what technological changes are to be introduced? What factors influence them? What constraints do they labor under? What is the classic impact of politics on technological change?

First, let us look at the response of traditional societies to technological change. The vogue is to present a single typology of traditional politics and their response to technological change. However, David Apter[1], a political scientist has made some interesting assertions which represent a departure from the monolith. Despite Apter's tendency to use overly technical language, I think we should examine his major contentions. He observed that the confrontation of the traditional with the modern is not a zero-sum game in which the traditional is completely annihilated by the modern. Sometimes, traditional factors seem to create in social structures, immobilities "that abort or minimize innovation." Upon occasion, a traditional society may admit technological innovation by transforming "exogenous features of social life partly into endogenous ones and thereby into living and continuous relationship with the past." He calls this traditionalism.

For analytic purposes, Apter divided traditional systems into two value systems: instrumental and consummatory. Instrumental systems are those in which ultimate ends do not color every concrete act. "If trade, new agricultural practices or administrative matters are introduced, the consequences are immediate, fragmentary and non cosmological."

Instrumental systems can innovate without appearing to alter their social and political institutions fundamentally because "innovation is made to serve tradition." The structural expression of the instrumental system is hierarchical, with a single command figure or king at the apex (e.g. Thailand, Morocco, Afghanistan, Iran).

On the other hand, the consummatory systems do not make a distinction between intermediate and ultimate ends. They are rooted in societies with pyramidal authority. In such systems "the state and society are elaborately sustained by high solidarity structure in which religion is a pervasive cognitive guide. He took the example of two short hoe cultures trying to adopt tractors. In the instrumental system the tractor will be viewed simply as a device to improve agricultural output. In the consummatory system, the change will disrupt the ritual of hoe making, the division of men's and women's work, the relationship between the agricultural rituals and the authority of chiefs. Consequently, it will be impossible for the political leaders to consider tractors simply in terms of increasing agricultural output.

Based on his examination of the reactions of Bugandas and the Ashanti and some observation about the Yorubas and the Hausa-Fulani traditional systems, Apter seems to have arrived at these general conclusions:

1. That instrumental systems will easily admit technological innovation until the principle of kingship is challenged;
2. That instrumental systems innovate by spreading the blanket of tradition upon change itself — joining the old and the new;

3. That when the central political principle is challenged the entire system is mobilized to resist change. In sum therefore instrumental systems do not resist technological innovation except if it implies fundamental political change;
4. That in consummatory systems all change is resisted; and
5. That if technological change comes to the consummatory system it produces social upheaval and breakdowns in customary relationships. Consequently, new social systems with new political forms emerge to tear down the old one.

In terms of our concern, then, Apter would say that in a traditional instrumental system, the job of a change agent is simple as long as he does not seek to alter the fundamental political authority relationship and that in such cases traditional political leaders offer maximum cooperation. In a consummatory system, all innovations are resisted often ineffectively and the impact of technological change on the system would cause profound societal discontinuities.

The crucial variables regarding the relationship between politics and technological change would be the nature of the traditional system which in turn is determined by the authority relationship and societal value orientation. Unlike Apter, I prefer to offer these to you as possibilities, not as proven hypotheses.

Our discussion cannot stop here because most of the newly independent states are, in fact, no longer traditional but transitional. Moreover, technological revolution has telescoped times, shrunk distances and interfered with many social systems and values. Technology has bombarded the traditional communities with such intensity as to cast doubt on the notion of efficacious selective modernization. Even if we agree that instrumental traditional systems retain their potency, the fact remains that most traditional systems are more consummatory than instrumental.

In the African experiences, many authority relationships were altered because of the imposition of colonial order which undermined the authority of the traditional elite, either by the arbitrary legal declarations, by the introduction of a new cash crop which created a new economic class, by the introduction of western diploma elite with unusually high leadership ambition and pretensions or by the subtly created overall feeling of inferiority and inadequacy among the traditional rulers.

For the most part, formal colonies and classic colonialists have disappeared. With this abrogation of power, attention turned upon the indigenous political leaders. For the indigenous peoples the question of successor political elite was largely settled, perhaps unconsciously, by the realization of the fact that in the new age one most important leadership criteria is the ability to understand and to take advantage of the new social order in which technology plays an important role. To say this is not to say that traditional establishments or traditional peoples cherished this situation. Many of them do accept it, however. In some instances traditional oligarchies have supported the transfer of power to the new elite, with a tint of enlightened self interest in the hope that selective modernization will greatly enhance the chances of the preservation of what they regard as sacred and vital.

The large question here is how does politics affect the adoption of technology in the new states? We cannot answer this question without first examining the new political class. Who are these political leaders? To some they are modernizers; I think this begs the question. Others simply call them the new elite. Among them we find:

1. Urbanized educated people,
2. Bureaucrats, some of them achievement oriented, others not so,
3. University lecturers,
4. Members of old elite capable of assuming new roles (educated chiefs), and
5. Military officers.

From this list one might jump to the conclusion that these are men with very deep sympathies for technological change, complete faith in science, unquestioning acceptance of western values and orientations, as well as unbridled desires to be modern. Let me caution against such monolithic perception of the new elite. Generally the profession of politics has many constraints. The constraints and problems are more overwhelming in new states than they are in developed ones. Let me outline some of these:

1. Oftentimes, the political leaders preside over culturally heterogenous entities which are not yet politically integrated or some that are indeed malintegrated;
2. They preside over populations which are largely illiterate, poor, and those with stagnant economies;
3. They find themselves leading people who have been exploited for so long by so many;

4. They are the leaders of disappointed people whose revolution of rising expectation has been or is about to be displaced by the revolution of rising frustration;
5. They preside over peoples whose loyalties tend to be parochial, more primordial than national;
6. Even among the new elites a considerable degree of primordialism and a lack of consensus exists; and
7. The viability of newly created institutions is often debatable.

This is the laboratory of the change agent as well as the environment of the political leader. We must keep these in mind as we address ourselves to this topic.

What are the classic obligations of the political sector vis a vis technological change[2]? Normally, the political sectors of the new states are expected to undertake planning and integration of development, i.e. draw up development plans which will explore and categorize resources available and set long- and short-range goals. In addition, the political sectors are expected to bring about greater production of goods and resources as well as their distribution. Furthermore, they are expected to increase the physical and social foundation for development and they are encouraged to make large investment in roads, communication, irrigation, canals, power, school buildings, and urban facilities. Finally, in the social sphere they have the obligation of providing for man power training, formal education, adult education, medical and health (facilities) and effective extention and information facilities. Of course, some of them act as midwives to important industrial projects and others are directly and/or actively involved in industrial and agricultural development. They are, therefore, very important in the adoption of technological change because if the political sectors should fail to perform these tasks or if they fail to produce effective institutions which will perform these tasks, technological change will be greatly handicapped.

Obviously, one most important reason why politics affects the adoption or rejection of technological innovation is due to the fact that in most of the new states and theoretically in a majority of cases, the political leadership decides which innovation will be introduced. Moreover, it establishes the national priority. It is reasonable to assume that the political leaders' choice are often affected by a number of political variables. Let me explicate. The location of an industry may be done solely on political ground. Sometimes, technical aid may be rejected because it comes from a country which a powerful religious group finds unacceptable. The decision may be made strictly on ideological grounds.

I suggest, then, that to the extent that political leaders play important roles in the determination of which technological change will be introduced or encouraged, political studies which shed light on the composition, social background, reference group orientation, and the ideology of the political class, as well as studies on the political frameworks in which they operate, will be most instructive. They will offer us important crucial variables.

For example, only few military regimes will undercut military technological innovation provided all the sections of the armed forces will benefit from it. Similarly, we cannot reasonably expect a legislative body dominated by rural interests to ignore technological innovation which it is convinced will be to the benefit of the rural folks.

Generally, many political leaders in the new states are very active in the adoption of technological innovations which will lead to improvement in the social well being of their people. Agricultural extension agencies and the government information machineries are usually generously made available. The effectiveness of these institutions cannot be assured in the face of foreign exchange problems, the difficulty of securing spare parts and the cavalier attitude of some government officials.

The lack of modesty on the part of many foreign experts does little to enhance the prospect for technological innovations. In many developing countries there is a very strong anti-foreign technical expert climate. I say this, aware of the fact that there are many instances where change has been introduced by committed foreign experts on a "low profile basis." In some parts of the world this is not the rule.

Government officials tell stories of technical advisers who seem reluctant to educate their understudy. Of course, this may not apply to the American experts, but there are many foreign experts who know a lot about technical "nuts and bolts" and very little about the culture into which they are sent. In some quarters, a technical expert without foreign consultancy experience is like an ambitious modern U.S. army colonel without combat experience in Vietnam. He may become a brigadier, but it will take some time.

The more modest expert who finds himself unfamiliar with the cultural terrain and refuses to do air-conditioned advising will, of course, immediately immerse himself in cultural induction courses. The problem is that, given the short-term assignments of such people, their terms are over about the time they are really equipped to do good. The point I wish to make is that the hood does not make the priest.

Many politicians in the new states have been innocent victims of innocent foreign experts. There is an irresistable urge to see any undertaking in which one is involved in superlative terms. We need to compensate for this tendency. We must be willing to accept the possibility that pre-packaged solutions imported from another time and place may sometimes fail.

Now to the Impact of Technology on Politics

Technology imposes considerable constraints on the politics of the new states, either because of the way they are introduced or because of the demands of technological management or because of the choice of the strategy.

The shortening of distances and the transistorized short wave radio constitute a blessing and a curse to political leaders of the new states. They present the political leaders with the necessary means of communication and transportation which may improve the political integration and mobilization of their country. At the same time, they make it difficult for political leaders to achieve negative development by lowering the expectations of their people.

Technology presents a problem for the political leadership no matter which of the two basic strategies they take to technological modernization.[3] They may opt for the use of the newest available techniques.

But this capital intensive strategy usually means the investment of the country's limited resources in economic undertakings which produce, at best, only a very small increase in employment figures. The country's unemployment problem continues in the face of increasing population growth. A dangerous lumpen-proletariat may come into existence. Another important consequence of this strategy is that is is likely to widen the wage structure and deepen the gulf between the rich and the poor. Such situations are not very conducive to political stability.

On the other hand, if the decision makers choose to modernize gradually, they may find their country a dumping ground for obsolete equipment without spare parts for replacements. Indeed, it may be difficult for their products to compete, not only on the international market, but also on the domestic market.

To some extent international politics has affected the relationship between technological change and domestic politics. Here I am interested in the international constituencies. Foreign aid officials and bodies have pet projects. Donor nations have priorities they would like new states to adopt. These forces also, explicitly or implicitly, make demands on the political leaders of new states. In some cases, these political leaders alter their priorities. Within the framework of the cold war and upon occasion, a quick change of political leadership could result. The often necessary dependence on foreign experts for the formation of development goals and the rapidity with which these personnel change, as well as the jealousy created by the foreign technical experts' life styles, render the ruling political class vulnerable to their supra national opponents and nationally sensitive citizens. In many countries, one hears the term cultural imperialism, neo colonialism and so on. Many, not all, of the politically conscious people who use these terms use them out of genuine fears.

Since this is a short presentation, no recapitulation is necessary. In my judgment it might be more rewarding for me to close with a few observations regarding the problem areas in the relationship between politics and technological innovation. I do this in the form of four questions. First, how much technological change can the society take without breaking the tenous integration achieved between the traditional elements and the progressive ones?

Second, how can political leaders deal with foreign technical experts without discouraging the competent and the well-prepared among them and without alienating the cultural nationalism of the national intelligentsia?

Third, governments in developing countries face very formidable tasks, but they seem to have a lesser capacity to grapple with them. Yet the application of new knowledge to human affairs has made government more embarrassive, and to some extent ubiguitous. In a real sense, there is a problem of "over load." How can political leaders deal with this problem of over load?

Fourth, how can politicians in new states deal with the decrease in the leverage available to them in the present paradoxical world order in which nationalism remains salient side by side with the proliferation of international organizations and commerce?

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ECONOMIC FORCES IN TECHNOLOGICAL CHANGE IN FOREIGN CULTURES

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I have been asked to address myself as to how economic forces determine the choice of technology in general and secondly, as to how such a choice affects foreign cultures. I will advance two propositions:

1. Foreign cultures, understood as the lesser developed countries, are dependent in the matter of technology upon a limited number of industrially advanced countries; and
2. The technology of the industrialized countries is often inappropriate for the lesser developed countries.

From this follows that the conscious or unconscious promotion of one's own technology in foreign cultures may be harmful to the recipient countries. If so, the recipient countries should try to limit their technological dependence by increasing their technological capacity and by installing defense mechanisms against the indiscriminate introduction of alien technologies.

Above recommendations appear to be but common sense. They nevertheless imply profound and radical changes of existing power structures within the lesser developed countries. They also imply possibly bitter and recriminatory relationships between the lesser developed countries and the industrially advanced countries.

Technology in its broadest sense includes the technical and managerial know-how embodied in physical and human capital. In Figure 1 we

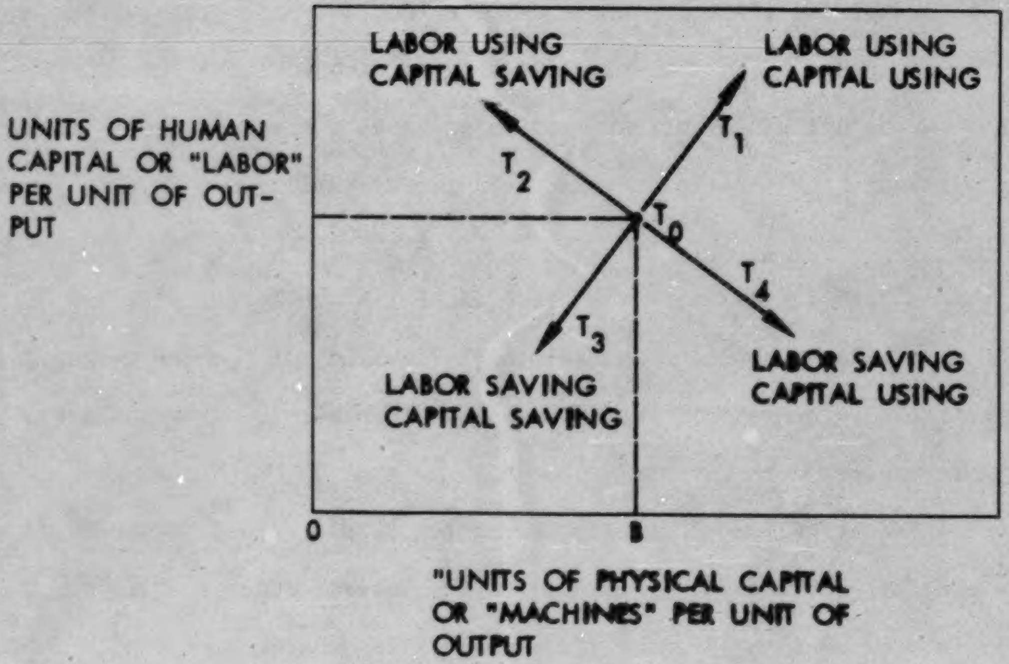

Figure 1. The choice of technique.

measure the units of human capital of "labor" per unit of output on the vertical axis, and the units of physical capital or "machines" per unit of output on the horizontal axis. A traditional technology T_o is then determined by a particular combination of labor and capital inputs per unit of output.

Technological change implies a change in the traditional input coefficients. This leads to two important questions:

1. What are the economic forces that underlie the direction of change? and
2. Can one control the direction of change, such as to make it confirm with widely accepted social objectives?

To answer the first question one must look at the motives of those who introduce new technologies. In a society like ours the introduction of new technologies lies primarily with business enterprises. Publicly funded research in universities and experiment stations may be able to generate new technologies, but they cannot by themselves make sure that inventions lead to innovations. As to whether an invention will lead to an innovation depends on the economic efficiency of the new technology versus the old technology, i.e. a new technology must be profitable if it is to replace a traditional one.

The industrialized countries have a remarkable record of economic development. The real wage rates in such countries today are at least seven fold of what they were a century ago. Yet the cost of capital, as expressed by some average rate of interest, has not increased. With labor becoming scarce and expensive, and capital remaining relatively abundant and cheap, it follows, that capital intensive-labor saving techniques became habitually profitable in the industrialized countries.

One might say, that the relative resource availability led to a particular direction of technological progress. It tended to absorb the relatively abundant resource, "capital," and economized on the use of the relatively scarce resource, "labor." The issue as to whether one ought to control the direction of technological change did not arise since the process spontaneously satisfied three important social objectives. It did not lead to chronic unemployment. The standard of living of the large majority of society, i.e. wage and salary earners, increased rapidly. Finally, the relative abundance of capital insured that the income inequality between those who derive their income from property and those who derive their income from personal services was minor and decreasing over time.

The contemporary situation of the lesser developed countries is quite different. The lesser developed countries are characterized by labor surpluses and capital scarcities. Income is extremely unequally distributed, with the professional classes and property owners absorbing a very large share of the national product relative to their members.

Table 1. Latin America: estimated income distribution, 1960.*

Income bracket (deciles)	Share of total personal income (percentage)	Average of personal income as a percentage of the general average	Annual per capita income (dollars)	Monthly average income per family
1st	2.1	20	80	40
2nd	2.8	28	110	50
3rd	3.6	35	140	60
4th	4.3	43	170	80
5th	5.4	55	220	100
6th	6.5	65	260	120
7th	8.1	80	320	150
8th	10.7	108	430	200
9th	15.4	155	620	280
10th	41.1	410	640	750

* "Elementos para la elaboración de una políticia de desarrollo y integración para America Latina." Document prepared by ILPES and DELADE, Santiago, Chile, Ch. III, p. 11 (July 1968).

The introduction of new technologies in such societies should fulfill the following social objectives.

1. They should be labor absorbing so as to reduce chronic unemployment;
2. They should lead to a decrease in the inequality of incomes, i.e. the economically disadvantaged should receive the major benefits of the introduction of new technology; and
3. The new technology should lead to a sustained increase in per capita incomes.

There is a potential conflict between the first and last objective. Suppose that a country has a given capital stock and an abundance of labor. National product will be maximized if we employ the maximum number of workers with the given stock of capital (see Figure 2). The

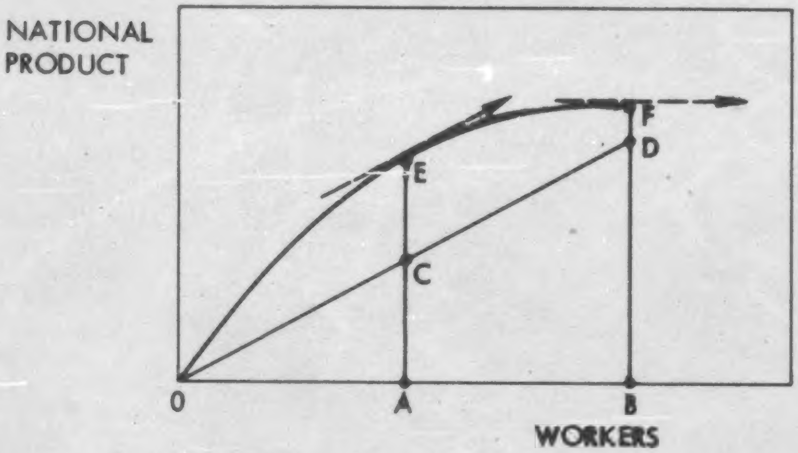

Figure 2. Maximum surplus or maximum employment?

appropriate technology is labor-intensive. In fact, one would use additional workers up to point F, where the contribution to the national product of the last worker equals zero.

The real wage rate must, out of necessity, be larger than zero. Consequently, some workers consume more than their contribution of the national product. A common saying in our own society says, that a worker should "earn" his wages. A worker employed beyond point A cannot "earn" his wages, because his contribution to the national product is less than his wages. If the owners of property were strictly rational they would not employ such sub-marginal workers, The income of the owners of property is maximized with a considerably smaller labor force, i.e. at point A where property income equals EC, and unemployment equals AB. It is not difficult to see that workers and employers will disagree on the appropriate technology to be used.

If one were to assume that workers save very little out of wages, it must follow that any addition to capital stock must be forthcoming out of the savings of the owners of property. At point A potential savings equal EC. An increase in employment reduces the surplus available for investment. More employment now, implies a reduction in the rate of capital accumulation. Little or no growth in capital stock implies that future incomes will not be very different from today's.

Whether to have more jam today or more jam tomorrow* can be illustrated by a practical example. We believe in quality education. More specifically we believe that graduate schools and research are socially desirable activities of a land grant college. Technical Assistance programs and foundations have tried to transplant such activities in many of the lesser developed countries, frequently with little lasting success. One wonders why. Graduate schools and research are highly capital intensive. This permits a future increase in the amount and quality of education.

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*The phrase is Joan Robinson's.

Yet students in lesser developed countries rarely riot because of the refusal of the university to establish graduate schools. Rather the opposite. Students demonstrate against graduate schools or capital intensive education because they realize that more capital intensive education must, other things being equal, be accompanied by a reduction in the number of undergraduate students now. Many foreign universities will, therefore, maintain graduate schools only if they receive adequate external financial support, for example, from foundations. The possibility of internal funding of such schools on a lasting basis is remote.

Lesser developed countries are increasingly reluctant to adopt the capital-intensive techniques of the industrially advanced countries. Such techniques do little to eliminate existing structural unemployment. They also contribute to more income inequality. An increase in capital intensity, at a given interest rate and wage rate, will increase the share of capital in national income. In other words, such techniques will tend to increase the income of property owners who already have a major share in the distribution of personal income. The fruits of technological progress are not shared by a majority, but pre-empted by a minority.

The lesser developed countries suffer from a scarcity of capital. The equilibrium market rate of interest, if left alone, would tend to discourage the adoption of capital intensive innovations. Frequently, however, economic progress is identified with the imitative adoption of the capital intensive techniques in industrialized countries. To make such techniques economically feasible in LDC's the government must subsidize the rate of interest. Industrial Development Banks will often lend at rates below the rate of inflation. Profits are made exempt from taxes if reinvested in fixed plant. Import tariffs are minimal for industries of strategic importance, and virtually all industries prove to be of strategic importance. Such measures obviously stimulate over capitalization.

One might ask why such measures find little political opposition. The answer is, that property readily translates itself into power. The upper classes dominate political decisions in virtually all lesser developed countries. It is never difficult for any dominant class to identify national progress with progress of one's own interests. Consequently, many fiscal and monetary policies, nominally decided in the national interest, nevertheless coincide nicely with the interests of a wealthy minority. Labor unions and other organized urban groups are frequently privileged elites themselves. Management, operating in an environment of administered prices, has little difficulty of working out a modus operandi with such semi-popular forces. Capital intensive techniques then, bring benefits to minorities rather than majorities. The introduction of such techniques, a high growth rate in National Product not withstanding, tends to maintain the status quo in an already unequal society.

Do the industrialized countries bear any responsibility for the chronically disoriented assimilation of technology in the lesser developed countries? In first instance, the answer would be no. But a moment's reflection reveals that the technological penetration abroad carried out by U.S. and European corporations is precisely that of the capital intensive type. Such corporations act under constraints of interest of headquarters, which do not always coincide with national interests. U.S. corporations, because of unlimited financial resources and experience, are often able to monopolize the strategic growth industries in lesser developed countries. They usually capture the most able nationals for their local management teams. Because of their size, their decisions as to the level of investment, the location of economic activity, the orientation of technology, and the utilization of domestic savings, are of strategic importance to the country. Frequently such corporations are but enclaves in a domestic economy. Their presence has no positive feedback effect upon the state of the arts in the rest of the economy. Such enterprises lack national identification. Nevertheless their size is such that governments must treat them circumspectly, even if this implies the interruption of autonomous national development.

A similarly pessimistic view is in order for foreign assistance and lending programs. Loans are frequently tied, such that the recipient country is obliged to import a technology which does not fit its needs. Indeed to the extent that income inequality and capital intensive technology are interrelated such loans may even defeat their stated objective of benefiting the economically disadvantaged in the LDC's. Because of this, many economists in Latin America think that the Alliance for

Progress, despite good intentions helped to maintain income inequalities, rather than open up possibilities for true economic development.

True development requires that the poor become increasingly productive members of society. Industrial production will then become oriented towards the mass production of simple consumer goods such as food, textiles, housing and public transportation. This cannot occur with a continued extreme inequality in incomes. The latter leads to the creation of separate markets for the poor and the rich. The latter will demand the highest quality consumer durables available at home or abroad. Import substituting industrialization policies frequently cater to this limited market. Since the quality of the product is frequently linked to the most advanced level of technology, foreign patents, licenses and equipment must be generously used. All of this costs a great deal of money. To maintain a semblance of competitiveness with similar imported products, domestic industries must be given tax rebates, tariff preferences, favorable financing terms, etc. Nevertheless, the domestic market is of such limited growth potential that such industries must receive above subsidies on a permanent basis. All of this in ultimate instance at the expense of the large majorities, who will never own deluxe automobiles, color television, or villas equipped with the best money can buy.

The solution to the technology problem in lesser developed countries does not lie in frustrating its penetration. Rather the decision making system must be modified in such a fashion that it does not produce the negative effects which we currently observe. At present the choice of technology is not made according to local factor availabilities but according to the requirements of an imported and alien technology. Secondly, the decision agents, be it foreign corporations or national propertied minorities, should be constitutionally constrained and given incentives to adopt the appropriate technologies.

This supposes that the country has a technological capacity. More specifically it supposes that economically efficient labor intensive technologies are available. This may not be possible in the short run. The attempt and failure by Communist China to produce steel by small scale labor intensive techniques demonstrates this. Consequently, the appropriate research infra structure must be set up. Currently, the lesser developed countries are spending 50 cents per capita per year on research and development, whereas, the U.S. and European countries spend an average of 60 dollars per capita per year on research and development. The imitative transfer of western technology should be avoided. This among other things implies a careful examination of the terms and objectives of foreign aid and technical assistance.

Research can be modern and advanced but it must be oriented towards the solution of local problems. Among these the strategic problems may require but little advanced research. Fiscal and monetary policies should be designed to favor domestically designed technologies and equipment. Foreign investment and international corporate decision centers must be constrained, so that their actions can be fruitfully integrated into pluralistic political societies. The foregoing policies are a first step toward eliminating the technological dependence of the lesser developed countries upon the industrialized countries. It supposes that the majority interest may prevail now, so as to bring about equality and prosperity for all at some later date. As to whether enlightened leadership will prevail over local and international oligarchies remains to be seen.

MORAL AND ETHICAL ASPECTS OF THE EXPORT OF TECHNOLOGY

October 19, 1972

MORAL AND ETHICAL ASPECTS OF THE EXPORT OF TECHNOLOGY

– THE MORAL QUESTIONS INVOLVED –

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In some quarters, the mere mention of "technology" is an invitation to impassioned controversy. It is not infrequently charged that technology inevitably culminates in the progressive dehumanization of man. What puzzles the proponents of technological development about this charge is that it appears to ignore the rather obvious ways in which technology contributes to the improvement of the human condition. Indeed, for all practical purposes, progress and technology have become inextricably interwoven in the twentieth century. Here, however, we have the origin of the problem which I propose to state and explore briefly in this essay.

Some time ago, an anthropologist was called upon to comment on the discovery of the Tasaday people in the massive forests of the Philippines. Quite naturally, he expressed great interest in these lovely, charming people. His concluding remark remains fresh in my mind. "Perhaps," he observed, "our study of the Tasadays will teach us much more about what life must have been like for Stone Age man. Perhaps we shall also learn something about what we have lost in becoming civilized." For reasons which are not entirely clear to me, this remark continues to echo in my mind. Recent visits by men of genuinely good will have resulted in the exportation of technology to the Tasadays. And it is quite likely that these people are now unconsciously caught up in the "progress-technology" syndrome of the twentieth century.

The Tasadays confront us with a devilish dilemma. On the one hand, they fascinate us for what and who they are in themselves, as well as for the information they may provide us in our effort to complete our own autobiography. On the other hand, we also experience a new and puzzling imperative to honor the integrity of the Tasaday culture. Indeed, we are keenly aware of the probability that by increasing our contact with the Tasadays, we shall inevitably corrupt their fragile world. By accident or design, all dilemmas are broken. What interests me about the Tasaday dilemma is our new sensitivity to their world and culture. It is this sensitivity which forces us to recognize that the exportation of technology is a highly complicated and confusing business. Much more than a sophisticated set of solutions to basic human problems, technology is the power to change, restructure, and reorient entire cultures. The same technology that fills bread baskets can also drain meaning and significance from the lives of men. Indeed we have learned all too well that technology cannot alter man's environment without altering man himself.

Perhaps the most effective way of getting at the moral questions involved in the exportation of technology is to begin with an assay of what we take our obligations to be in such a process. Our first obligation is to understand technology and its immense impact on our own world. We are also obliged to be as clear as possible that what we take to be a solution is just that. Experience has taught us that the effects of technology can be even more problematic than the problems we set out to solve by means of technology. The drama of the bicycle and automobile is a case in point. In 1910, the advantage of the automobile over the bicycle began to become clear. In 1972, it is the bicycle, not the automobile that has the edge. Strange? I think not, for in the sixty-odd years that have expired, we have learned something fundamental about ourselves as well as technology. We have learned that the interaction of quantity with quality cannot be ignored. The one does not always reduce to the other. We also have learned that ease and efficiency must not be allowed to become our sole standards of judgement. We have learned that there is an aesthetic dimension to life and living which is much more than a matter of quantity. Saving time does not always result in a better life.

Finally, we are obliged to be thoroughly informed about the people we propose to aid by way of our technological skills. The lessons we have learned about ourselves must be shared with those we propose to help. Too frequently in the past, we have rushed in with what we were sure would be a solution to the problems of other people, only to discover that our solutions were themselves the midwives of new, even more distressing problems. Put another way, we are not only obliged to understand ourselves but also to see others as they see themselves. Too frequently, technology is exported with inadequate appreciation for its impact upon the exporter, too little understanding of the importer. The exportation of technology must be carried out with the realization that people of different cultures are as dissimilar as they are similar. We must recognize that no nation, no people has a right to create man in its own image.

EXAMPLES OF HOW MORAL AND ETHICAL ASPECTS OF EXPORT OF TECHNOLOGY ARTICULATE IN THE REAL WORLD

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Introduction

1. Moral and ethical aspects of the export of technology are based on beliefs and values.
    - A. Beliefs are man's perceptions of the relationship between phenomena. They may be based on
        - (1) scientific truth claims about these relationships, or on
        - (2) "common sense" perceptions based on experience.
    - B. Values are perceptions of relationships that should exist between phenomena.
2. Beliefs and values vary from culture to culture, and within cultures.
3. The first step is to understand one's own beliefs and values.
4. The second step is to understand the beliefs and values of the cultures and subcultures in which you desire to, or are requested to interact.
5. There is the ever-present problem of salience — weighting beliefs and values, even if one has the data.

Examples

All of these examples are true, but oversimplified. Time will only allow an attempt to make several points. The first examples deal directly with moral and ethical considerations. The later examples deal more with how Western-culture-bound value systems impinge on our ability to define problems and possible solutions in "other"-culture terms.

1. Perfect welfare functions are "hard to come by." I was fortunate to be a part of a 13-man Ford Foundation team invited by the Indian Government to investigate "India's Food Crisis and Steps to Meet It." One of our major recommendations was the "Package Program." In oversimplified form, the recommendation was to commit optimum resources — best seed varieties, fertilizer, chemicals, machinery, farm management training, and price incentives — into approximately 50 of the highest production potential "rice bowls" located in various parts of India. Our objective was to get the greatest possible increase in food production. We presented this and other recommendations to Prime Minister Nehru. He questioned it on the following basis: 1) One of the basic tenants of the Indian independence movement was that all Indians would share equally in welfare advances; 2) this program would give preferential treatment to certain areas; and 3) the rice bowls chosen, because of their natural resources, were already better off than almost all the rest of India. The conflict was between a general welfare function and food production. As a resolution, there had to be at least two rice bowls in each state, which was basically a political compromise.
2. Sure we value human life, but the generalization gets operationalized differently. At a debate in a World Health Organization meeting, a strong, persuasive, emotional argument was made by a North European delegate for the world-wide ban on DDT. A major part of the argument

was based on possible long-term residual effects of DDT on humans. As the delegates were nearing agreement on the merits of the argument and moving to support of the ban, a woman delegate from a developing country in Southeast Asia arose and said, "We, too, believe in the importance of human life. We desire the opportunity to worry about residual effects on human life at age 65, but 15% of our population never reach age 15. Malaria is a primary killer. We need DDT to help more of our people live to age 15; we will worry about death after 65 later." The resolution did not pass.

3. Can Bengladesh make it? This is an example of a case of different normative criteria. I am indebted to Doug Enzminger, former director of the Ford Foundation in India, for this example. Basically, the journalists have written Bengladesh off as a basket case; it won't make it. They won't be able to provide shelter, food, clothing and minimum services for their population. Enzminger says they have great potential for making it, if we use Bengladesh criteria, not Western criteria. Their shelter consists of wood and grass shelters that, on the average, blow away once a year. They eat rice and vegetable proteins. There are two cotton dhotis per man and two cotton saris per woman. Children under 5 are basically naked. Minimum maintenance services can be provided despite disorganization, "take," and what appears to us as inefficiency. By Western standards, the case looks dismal. By localized cultural standards, it has great potential.
4. What a stupid way to set up a bureaucracy! But have you ever really looked at the way we do it? What are the objective criteria

by which we judge our own as being good? In a developing country, many different vertical bureaucracies are located in different central government ministries, each with component programs: agricultural technology, health, community development, cottage industries, housing, roads, and electrification. Each bureaucracy has a vertical structure from the central government to state government to district, and to the block-multivillage level through which they direct programs. Theoretically, the programs are integrated, priorities are set and programs are implemented at the block level. How can one possibly believe that program integration can be carried out at this low level of bureaucracy? Why don't they do it like we do? But wait a minute; how do we do it? We don't even try to integrate programs. Almost all our agencies run categorical programs from the federal to the local level with no attempt at integration. Thus, we have literally hundreds of specific functional programs operating independently. Individual agency programs are seldom packaged to meet individual or community needs in any wholistic fashion.

5. Sacred cows are considered to be economic units in India. The sacred cow of India has long been an example, if not a symbol, of nonrational behavior. India has more cows per capita than any other country. The fact that the role and the meaning of the sacred cow is deeply imbedded in the India cultural value system is usually given passing notice. The fact that the cow is used as a beast of burden and a source of milk and related products is also recognized. But, the fact that the cow consumes scarce and

valuable forage and that aged cattle are perceived to have no economic functions are emphasized. Now comes a recent study which indicates that, under at least short-run constraints, the cow is the most efficient producer of fuel for a large part of India.

Summary

Every culture approaches a high degree of "rationality" if one accepts its premises, assumptions, and basic value structure. This (both the generalization and value structure) is difficult, but crucial for those "exporting technology" to understand. This understanding is equally important whether the objective is to integrate technology into ongoing cultural patterns with an absolute minimum of change, or the expressed objective is to change cultural patterns. Of course, there is a third alternative, not usually considered. That is that such understanding may suggest it is best not to "export technology" in this particular instance.

I'M STANDING ON THE OUTSIDE, LOOKING AT THE INSIDE: A SIMULATED VIEW FROM THE DEVELOPING COUNTRY'S SIDE

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Gather 'round folks. I want to tell you a story. This is a story about a developing people. They've been developing for a long time. Archaeologists have some ideas about how long these developments have been going on. But the natives themselves, of course, have their own story about how they got here, and what they are supposed to do about it. For in their beginning, there was darkness and void. And then there was CHANGE. For their God made the heaven and earth, and He created light. And the light was good. And there was more change, and there were innovations. And the innovations were good: There was night, and there was grass, and there were trees. And then there was PROGRESS; and the progress was good: In the fullness of time, there were fish in the seas, birds in the air, and beasts on the land. And then there was man! And his God gave him dominion over the fish, and the fowl, and the beasts. Yea, dominion over every living thing that creepeth upon the earth.

The story goes on and on. As you know, the developing people of the world often have rich literatures full of fascinating illusions and endless circumlocutions. These people, as it turns out, were given THE WORD, and along with it THE MISSION of taking the word unto all the nations of the world. And the missions multiplied. There were agricultural missions, and technical assistance missions, and yea, even general cultural missions unto the yet undeveloped people of the world.

And some called it progress. But some did not, for they conceived it not. For some of the undeveloped people of the world had different stories about how they got here, and what they were supposed to do about it. And they changed in the fullness of time, but not according to the mission of the People of the Word[1].

The Word People, for example, had an agricultural system which had developed over thousands of years. They discovered the seed and how to domesticate it. Their scientists developed methods of planting, fertilizing, and harvesting the seeds such that the seeds were never touched by human hands. And the seeds were distributed throughout the society according to supply and demand. And the efficiency was great. They called the methods "technology" and the distribution "economics." And it was good. So the Word People took their mission to the peasants of Mexico. And the peasants were perplexed: for they too had discovered the seed thousands of years ago. But they grew the seeds in different ways, for they did not know that they had dominion over the earth. They performed magical rites over the soil before they planted the seed. For the earth could not be commanded to grow the seed, but rather must be urged as a co-equal force to assist in growing the seed. The seed itself had to be persuaded to grow — and the call to growth had to be in Nahuatl, because the seeds did not understand Spanish. But the seeds did grow and were harvested by human hands. And then the seeds were given to members of the family for moral reasons that the scientists of the Word People call "kinship obligations." Some of the seeds were given to "fictive" kinsmen, called compadres, for apparent reasons the Word People call "religious" and "political" as well as "economic." So the shiny tractors and other power machinery, the new seeds, and the considerably different distribution systems were not uniformly accepted, and the social ramifications of the new technology are still unfolding in diverse ways.

Now the Word People had more innovations. Their sanitary engineers decided to introduce modern toilet technology into a Mexican town. There was already a "developed" water system, and the natives had indeed long since given up the practice of relieving themselves in their fields. The Word People sanitary engineers, therefore, constructed the finest of flush toilets, based not only on their technological know-how, but their world view that defecation should be performed as a furtive and solitary act. The villagers, however, preferred their communal, 6-hole, outdoor latrine. As one Word People scientist observed of an upper class townswoman, she continued to use the outdoor facilities where "her friends joined her a time or two a day, and they passed a pleasant social hour, talking and smoking cigarettes."[2]

To the north of Mexico, yea indeed, within the very land of the Word People, there reside natives whom the Word People view as undeveloped. The Navaho, for example, do not believe in the germ theory and in personal health which are part of the truth-system handed down to the Word People from their holy mountain several thousand years ago. So the Word People introduced hospitals, modern medicine, and germ-free, value-free doctors garbed in white coats. The Navaho eschewed the distant, impersonal hospitals and the doctors in their ghostly gowns. They perceived illness differently within the relationship they have with their holy mountains. They preferred, for a time at least, to diagnose their "illnesses" by hand trembling and to seek their "cures" among kinsmen in dirt-floored hogans. There they were restored to harmony within the universe by songs and chants and sand paintings.

Even back home among the Word People, however, there is not complete agreement on the Word and the causal effects its transmission may have on the rest of the universe. Yea, for example, when it was decided by the Word People decision-makers that they could save time by turning ahead the hands of their clocks, one developed citizen from the town of Indianola (graciously named after the undeveloped aborigines of the land) responded as follows:

> "A child gets up in the morning under daylight time and cries because he has lost an hour of sleep. A parent has to whip him to get him to go to school. Maybe he has had breakfast and maybe not.
>
> He whines all day. When he comes home, his parents give him aspirin. We are living in a drug age. These school children are so worn out and their nerves are so busted that they have to have drugs. Then when Communism comes along, what are we going to do?"[3]

The story I am telling is far from told, but, in the fullness of time, as it is said, "I have spoken."

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MORAL AND ETHICAL ASPECTS OF THE EXPORT OF TECHNOLOGY

-THE FOREIGN EXPERT-

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Of the different shades of meaning associated with the words moral and ethical, I shall use moral here to mean a code of conduct or behavior arising from a sense of right and wrong, and ethical to mean an approach to behavior from the standpoint of objectively defined, but essentially idealistic standards of right and wrong. Those standards were dealt with by my colleagues who preceded me on this panel.

It may be said that the moral and ethical questions are of primary concern to the decision makers; to those individuals who are in charge of organizations involved in "planned change" or in the export of technology. The expert who is hired to give professional advice in a project may think that his role is to carry out the technical plans. He is not likely to consider the moral questions involved. However, the American expert working overseas is likely to face some tough decisions, many of which involve ethical questions. For example:

1. Because of his relatively short tenure, he might be under some pressure to produce quick results. This pressure may come from U.S. supervisors, from his native colleagues, or from his own desire to accomplish "something" during his stay overseas. This may produce disjointed and flashy efforts.
2. It is easy enough for an experienced man to identify problem areas. One is always tempted to make grandiose plans to overcome these problems, when perhaps his primary responsibility

is to help his native colleagues to understand the nature of these problems and help them find their own solutions.

3. Because of his prestige, the advisor's word carries a lot of weight:
    a. He should be aware of the possible effects his advice may have on certain groups and make his colleagues aware of these effects;
    b. In matters where expert opinions differ, one should present as honestly as one can the different points of view.
4. It is difficult for an experienced man to recognize that it is his responsibility to relate his experience to local conditions and needs. Projecting a professional experience to a new setting can be demanding even for an experienced man.
5. In a foreign assignment one may have several agencies looking over his shoulder; the foreign expert may encounter conflicting interests and be given contradicting instructions. Ethically, to whom should his commitment be?
6. It may sound too obvious and elementary, but I feel it is important to mention here that a foreign expert should maintain proper professional attitude and behavior. This includes refraining from unnecessary criticism of local ways of doing things, setting and giving examples in such things as seeing a job through, keeping schedules and appointments, etc.

Finally, it is my feeling that in spite of the disenchantment in many quarters with aid programs, the involvement of experts from the

West in programs in industrially developing countries is likely to increase in the future.

If I may indulge in giving advice to those who are considering overseas assignments: Do not look on such assignments merely as pleasant travel experiences. There are personal rewards, it is true, but your own personal enrichment is likely to come through conflicts and through encountering many difficult problems.

INTRODUCTION OF ENGINEERING TECHNIQUES IN DEVELOPING COUNTRIES

October 26, 1972

INTRODUCTION OF ENGINEERING TECHNIQUES INTO DEVELOPING COUNTRIES — SOME EXAMPLES FROM GHANA —

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During the period that I had the pleasure of working and living in Ghana (Professor of Agricultural Engineering, University of Ghana, 1969-70) much change was observed. It was a period when the country that gained its independence from the British Colonial system held its first election since a military group had taken over the government from Kwame Nkrumah, the first President of Ghana. A great deal of the activities relating to development were first initiated some years ago and were continued by the different governments in power, with some changes in the countries providing the aid but the general pattern of development remained generally unchanged.

I would like to discuss three different examples of where engineering technology was introduced and some of the observed social changes that resulted from this technology. The three examples are the Volta River Basin project, the introduction of a farm machinery factory, and the tractor hire stations in Ghana.

Before discussing the three examples I would like to mention some constraints to the introduction of new technology. These are not to be considered a complete list, but those observed as constraints or obstacles in the path of some of the developments observed. These constraints to change are:

1. Tribal laws, customs, or traditions. It is not to be inferred here that tribalism is either good or bad. I believe that in much of Africa, where there is a frequent and almost continual

change in the ruling government, the tribe with its well-established laws and customs, may be the one strong institution that prevails and in that respect it maintains stability and is good. When one attempts to introduce new technologies or practices, however, the customs or traditions of the tribes must be considered. One has to work within this framework, and this can sometimes be a blessing and sometimes a rather formidable obstacle.

2. Land tenure systems. The land tenure systems may be difficult for expatriates to comprehend due to their complexity. The systems often vary from tribe to tribe and anyone working with the country as a whole needs the counsel of competent native experts to deal with the problems associated with land tenures. The land tenure systems are subjects of research of a number of African scholars and the African governments are also trying to modernize the land tenure laws.
3. Limitations of foreign exchange. Since much of the introduction of new technology often means the importation of equipment, foreign exchange becomes a definite limiting factor.
4. Local politics. The competition for influence is a fact with which one must contend. Any expatriate working in a developing country soon learns to work within the local political framework or finds most of his efforts in vain.

The Volta River Project

The Volta River Project was started soon after Ghana became independent in 1957. A large dam was constructed which created one of the largest man-made lakes in the world. One can well imagine the problems generated by such an undertaking in terms of people involved. Many people had to be resettled and new villages had to be established. A great deal of thought went into the planning of this project and the studies concerning the problems of resettlement of the people has been well documented.

Many of the problems associated with the construction of such a large dam are quite similar to our own TVA project. Many of the farmers who were formerly cultivating the rich bottom land along the old river had to be moved to higher elevations often to land less fertile. Many of the farmers changed their occupation and became fishermen or headed for the growing cities.

Along with the many problems came benefits and opportunities. The dam was economically justified through the electricity that was produced. The immediate customer was a large aluminum smelter that processed bauxite shipped from other continents and shipped aluminum ingots to the rest of the world. The smelter was located at Tema, a small fishing village of a few thousand, which soon grew to 40,000 to 50,000. A modern city was created, attracting other industries including a food processing complex, a battery factory, a manufacturer of hand tools and a modern shipping port. I understand a number of other new industries have started since my visit.

All of these industries created jobs for a fast-growing population. The plant manufacturing hand tools such as the hoe and cutlass made it possible, for the first time, to purchase such a tool that was not imported. The generating plants at the dam were of sufficient capacity that in addition to the needs of the aluminum plant, electricity was exported to two neighboring countries. All of these projects generated much needed foreign exchange for a country primarily dependent upon cocoa and lumber for its exports.

The Volta River project also made it possible to inaugurate an electrification plan for the rural areas as well as the cities; and also made available "pipe-borne" water to many villages. One need only see the many man-hours spent carrying water or witness the opening of the spigot in a village for the first time to realize the impact that such a program can have upon the people. The project also increased the fresh water fish that were harvested in the country and thus added to the supply of food that was available.

I have recently read, in the popular press, that there are second thoughts about the advantages of the large dams. In the case of the Volta River Project, I believe the benefits will out-weigh the costs (both social and economical).

The Introduction of a Farm Machinery Factory

A new farm machinery manufacturing plant, Agricultural Engineers, Ltd., was established soon after Ghana received its independence. The output of the plant included the manufacture of garbage cans, simple tillage tools, equipment for a growing chicken broiler-feeding industry and cocoa drying equipment. In addition, a number of implements were assembled from imported parts. While the technology being introduced was simple by our standards, it was a beginning of an industry without wasting foreign exchange. The resulting industry created jobs in the factory and provided local businessmen with a product to market and contributed to the agricultural production of the country. All of the items were formerly imported.

The Tractor Hire Services

A large number of tractors and quantities of cultivating equipment were imported soon after independence. The first equipment was primarily from East Europe and Russia and the tractor hire services were originally organized, probably, with advice from those countries. The tractor hire services were not too successful for reasons other than their organizational structure, although this was changed several times.

The principal difficulty with the tractor hire services was:

1. The lack of trained operators;
2. The lack of trained management personnel;
3. The lack of planning for the importation of spare parts with the result that 30% to 50% of the equipment was not in serviceable condition at any one time; and
4. The difficulties which always exist when trying to operate production equipment with a government agency. The resulting administrative inefficiencies increase the cost to the country considerably.

In spite of the many difficulties, there was evidence that the tractor hire services were well received by the more progressive farmers. In 1970, the government was making it possible for individuals to purchase the equipment and operate private tractor hire services. The government was hoping to rid themselves of some of the problems that existed through a government financing scheme for those purchasing the equipment.

An individual often needs to question whether a country is really helped by the introduction of mechanization, when the country lacks the resources to purchase the necessary equipment. However, the issue really is whether or not we can deny them the means to produce their own food to the best of their ability. Many countries can and must produce more of their food in order to even survive and we must assist them in finding a way to do this within their social structure. Technology can help them and can do so without destroying their social values.

An individual working with the mechanization of agriculture in a developing country is often challenged by those who point to the statistics on unemployment. However, because of the labor requirements in agriculture being so seasonal, programs designed to increase the manual labor into agriculture not only fail to lessen the unemployment problem but also fail to add to the overall production of food.

Ghana had an unemployment problem. But, at the same time, Ministry of Agriculture reports continually stated that crops were lost due to the fact that labor was not available at harvest time. In addition, much of the country, as in much of Africa, is of such terrain that larger equipment and large-scale farming is the only possible way to increase the production of agricultural products.

ENGINEERING EDUCATION: INDIA, 1965-1967

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As a civil and highway engineer, I had an opportunity to sign on as a teacher for a summer institute program which was being held in India in 1965. I was assigned to teach in Calcutta. The thrust of this program was to try to help engineering education in India become a stronger, more viable, force for the development of the country. As I will point out in a few minutes, the Indian educators themselves recognized that their system had certain weaknesses, among them the lack of good teachers. In some places, there was a shortage of teachers; in other places, there were teachers whose qualifications were somewhat less than desirable.

In 1963, some survey work was done in cooperation with the Government of India and USAID. It was felt that an overall project could be developed, wherein Indian teachers in all scientific fields, such as physics, chemistry, mathematics, and biology, as well as engineering and technology, could improve their qualifications by attending summer institutes. This was tried on a trial basis. The first trial of the engineering and technical institute summer programs was in 1964. These proved to be very popular.

The idea of the programs was that a group of 50 to 60 Indian teachers from some locality would come to a school, university, or college during their summer vacation. The two governments provided them with subsistence payments, all their textbooks, laboratory apparatus, and everything else they needed for the program. A team of two to four experts put on a summer program in their own technical specialty. In 1965, the program was expanding, and I received a contract to teach in Calcutta in a technical field with which I was familiar.

USAID had a contract with various universities to provide the American teachers to go to India. The University of Houston had the contract for staffing technical institute groups. They recruited from various engineering technology programs around the country, and I was asked to join the program.

The program doubled in 1965, and again in 1966. This meant that someone had to stay in India full-time with the program after the rush of the summer program and its briefings and debriefings. There had to be a continuing effort to insure the organization necessary to initiate and maintain these summer programs. This created an opportunity and I was asked if I would like to take this on. I went back in 1966 and stayed until 1967.

This new position meant that I had to crawl, as a fish out of water, out of my own particular technical field and deal with programs across the engineering spectrum. It meant that I could not hope to be technically competent in all summer institutes with which I was dealing. It was actually an administrative position. I was essentially trying to make sure that the inputs to these summer institutes from both sides, which included manpower, funding, textbooks, and equipment, got to the right place at the right time. There were 24 locations strung all over the country.

Why was this effort necessary? I'm going to give you a few figures and a little background from a document I had access to right after I arrived in India. It concerned engineering manpower in India and where it stood. It was published and printed in 1963. Remember, this was nearly 10 years ago, and India achieved her independence in 1947.

India was under British colonial rule for 200 years prior to achieving her independence. Most of the other colonial powers, which have since won their independence, were not colonial countries as long as India. This was a period of several generations. The British had always considered India a model, because of the very small number of British nationals who administered the colonial government of India. This meant that great numbers of Indians were trained to help administer the colonial government. This was the system in which engineering education got its beginnings in India, largely in the fields of civil, mechanical, and electrical.

This was engineering education, not for the development of India, but to develop the products and produce of India to the point where exports, valuable to the British government, were created. For example, civil engineers were trained and employed primarily to build railroads, so that produce could be transported from the point of its production to the ports. Mechanical engineers were trained to make sure that the equipment necessary for transportation and power use and generation was available. Electrical engineers were also trained for the generation and use of power. All of these efforts were designed to promote the exports which the British found necessary to make a viable colonial structure.

In 1947, when India did achieve her independence, there were 45 engineering schools. Twenty years later, there were 115 engineering schools. There was available capacity for 4100 students in 1950; 20,800 in 1963. This shows a five-fold increase in that 20-year period. The polytechnic level, or technical institute level, started at 43 technical institutes in 1947, and increased to 248, a very significant increase, in the same period. The capacity increased from 5900 students to 39,700. The idea is that enough technical institute capacity was developed so that two technicians could be trained for every trained engineer.

There are five-year engineering programs and three-year technical programs there. The difference is that the secondary system takes a student through the 11th grade, and the 12th year is actually spent in the technical school of their choice. The 12th year is perhaps a little more pointed towards the technology that the student wants to pursue. I think that this might be a good idea, because in India a student may go all the way through 11th grade and never have a chance to get his hands on some tools or build anything; build a transistor radio, fix his bicycle, or whatever. The Indian students do not have the opportunity in their early lives to become technically oriented, as the children in this country do. I think it may be more efficient to have that last year of high school where a student gets his shop training or where he gets things allied to his technology.

The problem with this whole system was that the attrition rate for engineering students was around 50% (in 1963), and the attrition rate in technology students was about 65%. I began to notice these alarming figures while reading that manpower publication.

There were several reasons for this problem. One of the key reasons for this problem was that the schools were administered externally by the British. The state governments actually controlled the schools, though a principal was present at each school. External examinations caused a continual erosion of the quality of education. Sometimes the external examiners, or the people in the state government offices were a bit whimsical. They would ask questions on the yearly exam designed to embarrass the student or his teacher, or both, rather than to find out what the student really knew. Teachers were evaluated on how many students passed or failed this exam, so the next time that teacher taught that course, the answers to these whimsical questions were included in the curriculum. The curriculum swelled and swelled, getting further and further away from fundamentals of science and fundamentals of engineering science. Without an autonomous structure, this can happen.

Because the attrition rate was going up on a geometric progression instead of a straight line, Indian educators began a self analysis. They discovered that a teacher shortage and poor teacher qualifications continued to surface throughout all of their studies. They began to look for a mechanism to provide better teachers, make for more efficient teaching, make better use of the teachers they had, and improve teacher qualifications.

We were able to identify some administrators in various state governments, including the top director of technical education in a couple of cases, who were sympathetic with the problems in the schools. They were willing to back off and let the schools have some of the power to make their own decisions, to tailor their courses to the local needs, and to strengthen their curricula by getting back to the fundamentals of engineering. We found a number of teachers and principals who wanted to join this effort. The Americans believed that we should gradually develop Indian expertise and allow them to conduct their own summer institutes. The number of Americans was falling all the time, and the number of well-qualified Indian teachers was increasing, so they were actually running their own institutes.

In the 1965 summer program, and for two years after that, we were able to have at least one teacher from each of the engineering schools and polytechnics in one or more of the institutes. In most cases, we had several faculty members from each school attending one or more of the institutes. The Indian teachers are talking about follow-up programs, establishing curriculum development centers in several of the other states, and experimental courses.

The Indian engineering education system does have five top-level autonomous engineering schools. These were conceived about five years after they gained their independence and they are doing a magnificent job. But there's a long way to go, primarily because, per capita, India is only graduating one tenth as many technically trained people as the U.S. is, and this makes a difference.

INTRODUCTION OF ENGINEERING TECHNIQUES IN DEVELOPING COUNTRIES

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Ethiopia is a land of contrasts; it has 100 tribal languages, climate from the tropics to the temperate zone, mountains, plains, deserts, and lush growth. Much of the land is fertile and has great promise for agriculture; so far it is not so rich in minerals, but geothermal possibilities are large.

Emperor Haile Selassie I is probably the oldest ruling monarch in the world. He began his reign in 1930. The Italian occupation from 1936 to 1941 was a tragedy, but it did succeed in bringing the 20th century to Ethiopia. The Italians built 10,000 miles of all-weather roads and started small industry, plus introducing modern agriculture. The Emperor gave amnesty to 40,000 Italian farmers and artisans at the war's end.

My introduction to Ethiopia came in 1956 as a result of a three-year contract to teach in the new Imperial College of Engineering, opened in 1953. The Emperor had asked that the College be modeled after an American Institution. The first dean was a civil engineer from Colorado State University. He returned to the United States in 1957 and I took over the dean's post for the next two years. The first graduating class in 1958 included six civil engineers and two power engineers; total enrollment was 100.

Our sister institution, University College with 350 students was run by the Jesuits, and included an engineering department. Early in my appointment this duplication was mentioned because of the extra expense of operating two tiny engineering groups. I proposed that one of the two be terminated as an economy measure. This was done and University College, after eliminating engineering, was expanded in the sciences and humanities.

Other sister institutions were the Swedish Building College with 100 students, the Agriculture College at Alemyha, started by Oklahoma State University with 150 students organized through a USAID contract. The Telecommunication Institute, a two-year institution with 90 students, was opened under the auspices of the United Nations. The Public Health Institute, also a two-year program, was started by USAID. In the early 1960's, Haile Selassie I University was organized and took the four-year colleges under its guidance. Today it is a thriving institution with 2,500 students, and a medical school underway.

Engineering techniques were also being introduced by other groups and institutions. Perhaps the largest at the time was the Imperial Highway Authority, organized by the U.S. Bureau of Public Roads. Their big task was to repair the badly deteriorating highway system. Following World War II, the usable highways had dropped to 3,000 miles, due to washouts and lack of maintenance. The early staff was made up of "forengies" or foreigners, but as graduate Ethiopian engineers were trained, they quickly took over the engineering and management posts. The same is true in the development of the Ethiopian Airline, under the original direction of TWA.

The Dutch built a sugar refinery on the Awash River in the area soon to be affected by irrigation from new dams built by the Italian government as part of the war reparations. A new textile mill near

Addis Ababa was built with Indian capital and direction. The Yugoslavs built and operated a cement mill at Dire Dawa. Early in the century, the French built and operated the narrow gauge railroad from Djibouti; ownership is jointly held by the two governments. In the 1960's, the Russian influence grew with a technical high school in Baha Dar and another institution in Addis Ababa, where a Russian hospital had been serving the country since Czarist days.

Ethiopia's agriculture is the chief source of government income, through export duties on coffee, oil seeds, hides and grains. Coffee continues to dominate this income. Tourist income is growing, as the hotel system expands into areas where the roads are renewed. Few places in the world have such spectacular scenery as Ethiopia, with its Rift Valley, Blue Nile gorge, and terrain of such variety. Ethiopia involves an area of land the size of Texas and Oklahoma combined, with some to spare, and has a population of 20 to 25 million.

The students of the College of Engineering in the early days were on 100% scholarships, which might be expected to cause difficulties; this was not the case, beyond the high cost of such a system. More recently, the scholarships have been dropped, but tuition remains very low. All students are required to drop out for a year of teaching after completing the junior year of college. It was thought that the engineering students would not be willing to get their hands dirty with lab problems. Since the faculty had no compunctions in this direction, the students pitched in without trouble.

Learning to drive was another matter. The Ministry of Education had provided us with a Volkswagon "bug" and a chauffeur; so we tried out the chauffeur as a driving instructor with good results, although it was slow. When one has never had any childhood experience with wheeled toys, it is not so easy to learn the "feedback" needed to steer an auto. Our five-acre playing field made a safe place to teach driving. It was necessary to start in first gear, since the course taken was sure to be erratic, with a quick turn to the right and then to the left. The driver's fellow students had a hilarious time following this unusual start, but in a few lessons the trick was learned.

We made only one critical mistake in that we never took the students out on country gravel roads. Later, when a graduate was working in the "bush" he pulled rank on the chauffeur assigned to drive a truck load of men to a distant job. The young engineer took over the wheel and slid off the road at the first sharp gravel turn in the road, resulting in the death of the chauffeur, who should have been at the wheel.

Staff problems might have been expected, as we began with ten nationalities among the original 17 instructors. Beyond the need to protect the Indian instructors on grading, there were no difficulties. The students knew that at that time the Indians were better off in Ethiopia than in India, so there was a tendency to intimidate them. This called for some reinforcing by the dean. One other problem developed which every administrator must sooner or later face, i.e. someone who does not measure up. Unfortunately, this situation involved a fellow American on the faculty. He had to be returned home, a most distasteful, but necessary task due to his misfeasance and malfeasance as an instructor.

The matter of unequal pay for the same task, done by persons with the same training and ability, would seem to be a source of problems.

For instance, my colleague, Ato Makonen Wolde Amlak, had his BS from Iowa State in civil engineering and was every bit as good an instructor as I. His salary was $450 Ethiopian while mine was considered on the basis of being a European (Americans and Europeans used the same scale) at $1,000 per month. Indians had yet another scale of $750 per month. This was all part of the supply and demand of teachers. "Forengies," or foreigners, were on a three-year contract and went home after the contract expired. The Ethiopian at $450 would be a big man in his own country since the day laborer earned only $30 per month. Here again we see the contrasts in Ethiopia.

The lack of workmen's compensation insurance proved to be an interesting problem. Our compound (a large enclosed area for buildings and playground) not only housed the College of Engineering, but also the Technical High School, and the furniture factory for the Ministry of Education. The latter produced chairs, desks, and tables for use in classrooms all over the country. A Norwegian instructor from the technical school had been placed in charge of the furniture factory and was doing a good job.

He arranged early in his career to have a voluntary fund for use when someone was injured as a result of the table saws and other hazardous equipment. Everyone put a small part of his pay aside so that when an injury occurred, funds were available to provide compensation while he recuperated. This plan worked for a few years until someone reneged; then it fell apart. A man was injured then and brought suit against the Norwegian. The Ministry of Education did nothing to protect him.

This made us realize that we were also in jeopardy as far as labs were concerned, in case a student were to be injured. We presented a solid front and over a long period of time we finally persuaded the Ministry to give financial backing to the Norwegian, so as to show we all would be given the same treatment in case of a similar occurrence. It took a year to accomplish this task. Meanwhile, the Norwegian, who was of a nervous temperment, had many a sleepless night wondering how soon he would be put in jail.

All of us had visited the jail to take food to the school warden. He had been incarcerated due to a riot between the Tech School students and the nearby Commercial School students. One student had been killed by stones the students hurled at each other. Life was not without its bad moments.

One recurring problem which resulted from the hierarchy should be related. Salaries for any school system are 70% to 80% of the expense, yet operating expenses are necessary for supplies and such. There was supposed to be a sum of money in the budget for gasoline needed by the dean's school Volkswagon. Also, minor items like a simple faucet washer often could not be obtained, even if we found the money in the budget. Such small things were slowly corrected as we had them mailed from the U.S., without recourse to import duties. Anything sizeable would be subject to a 100% import duty if for personal use, or, if for school use, there would be much red tape before it reached its destination.

In the case of gasoline for auto use, the staff often used their own autos for school purposes, rather than eliminate some function. The matter could get critical, as in the case of an inspection trip for the students to the new dam on the Awash River some 90 km to the south. The students had obtained an army truck for their conveyance, but did not get gas for it. When one digs into his own pocket for gas for an army truck, it is a formidable sum, since the truck got one or two miles per gallon and gas cost 80¢ per gallon.

Another frustrating problem was the lead time for supplies for labs such as chemistry. We allowed a lead time of one year, since these supplies had to be imported and processed by two ministries: finance and education. Before the supplies arrived, a new Ministry of Supplies had to be hurdled and this added six months to the problem.

Musical chairs among the higher officials in the various ministries was another problem one would not have expected. The Emperor had a habit of rotating the persons in high posts every two years, or so. In two years as Dean, I was under three different bosses. Each new man had to spend much time learning the ropes of a new assignment. We in the U.S. have similar problems with some elected jobs of short duration, such as two-year terms for governors. It has been said that one who works in a foreign, developing land must have great patience; this trait plus a sense of humor are most necessary. Many things happen which are peculiar by one's own standards and the reasons do not become apparent until much later.

There are still some broad-based problems which Ethiopia faces and these are repeated in every developing country. Where do they get the necessary funds for widening the base of education and to explain agriculture and industry? Where will Ethiopia get the funds to develop the large geothermal energy sources, and thus bring an abundant supply of electricity to much of the country? How can the public school system be expanded to raise the literacy level from the present five or ten percent? Excluding military aid, the U.S. is not as generous, on a per capita basis, as some of the countries of Europe in giving funds to developing countries for economic purposes. In the past, much of our generosity seemed to be induced by a fear of the spread of communism. An example is the Marshall Plan and the aid plans which followed it.

As one looks to the future, there may be some increase in our generosity, due to the findings of the Club of Rome in their publication "Limits to Growth." Because of exponential growth among all the "have" countries, we may soon (100 years) run out of resources and develop too much pollution and population. Assuming that some control is possible, it surely must come from the "have" countries. The Stockholm Conference in 1972 demonstrated rather fully that the developing countries are not about to lessen their efforts for some of the "cake," even though it means creating much pollution and using still more of the limited resources. This means the "have" nations must take the lead in finding controls, while at the same time, helping the developing countries on the matter of capital acquisition. I am hopeful of this outcome and believe we will find it to our own interest to be more generous with the developing countries, while we also attack the problem of limiting our own runaway growth.

COMMUNICATIONS AND THE ADOPTION OF TECHNOLOGY AND SOCIAL CHANGE

November 2, 1972

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COMMUNICATIONS AND THE ADOPTION OF TECHNOLOGY AND SOCIAL CHANGE

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During the past few decades there has been increasing interest in social change. Of special interest to social scientists have been the processes by which new technical and social ideas and products diffuse from one culture to another. There has also been interest in the way these innovations diffuse within a culture, and in the decision-making processes through which individuals adopt or reject the new ideas.

The innovations with which we have been concerned have been myriad. On the technological side they have been as varied as transportation systems, including railways, automobiles, highways, and airplanes; communication technology, including printing processes, telephones, radio, and television; and agricultural production systems including improved strains of plants and animals, fertilizers, and chemical pest control agents. There has also been interest in the diffusion of social innovations. This has included concern with the spread of political and religious ideologies, and it has included concern with the spread of specific ideas such as kindergarten and modern math.

Research scientists have been interested in understanding and explaining how and why such change comes about and to explain the factors which speed up or hinder the utilization of innovations. To date, more than 1,100 empirical studies of adoption and diffusion processes have been completed in the fields of anthropology, sociology, medical sociology, education, communication, and marketing[1]. Nearly half the work has been concerned with the diffusion of agricultural innovations. Six universities, including Iowa State, Wisconsin, Michigan State, Missouri, Kentucky and North Carolina State, have been the center for much of the activity. During the past decade, there has been a rapid growth in the cross-cultural testing of adoption-diffusion concepts.

From the research conducted in these different areas several concepts, models, and frameworks were developed. Our goal today will be to summarize a few of the concepts. We will first present a general model of the diffusion system, and then apply this model to the diffusion of a specific innovation in the U.S., the diffusion of hybrid seed corn. Then we will attempt to apply the same model to the situations found in many developing countries, comparing and contrasting these situations with the U.S. environment for change. We will then delineate some more traditional concepts of the adoption-diffusion processes and look at some of the things that speed up and hinder these processes.

The first model we will examine was proposed by Sociologist Milton Coughenour (Fig. 1)[2]. It is a macro framework for examining a nation or some other large social grouping as a diffusion system. Within this

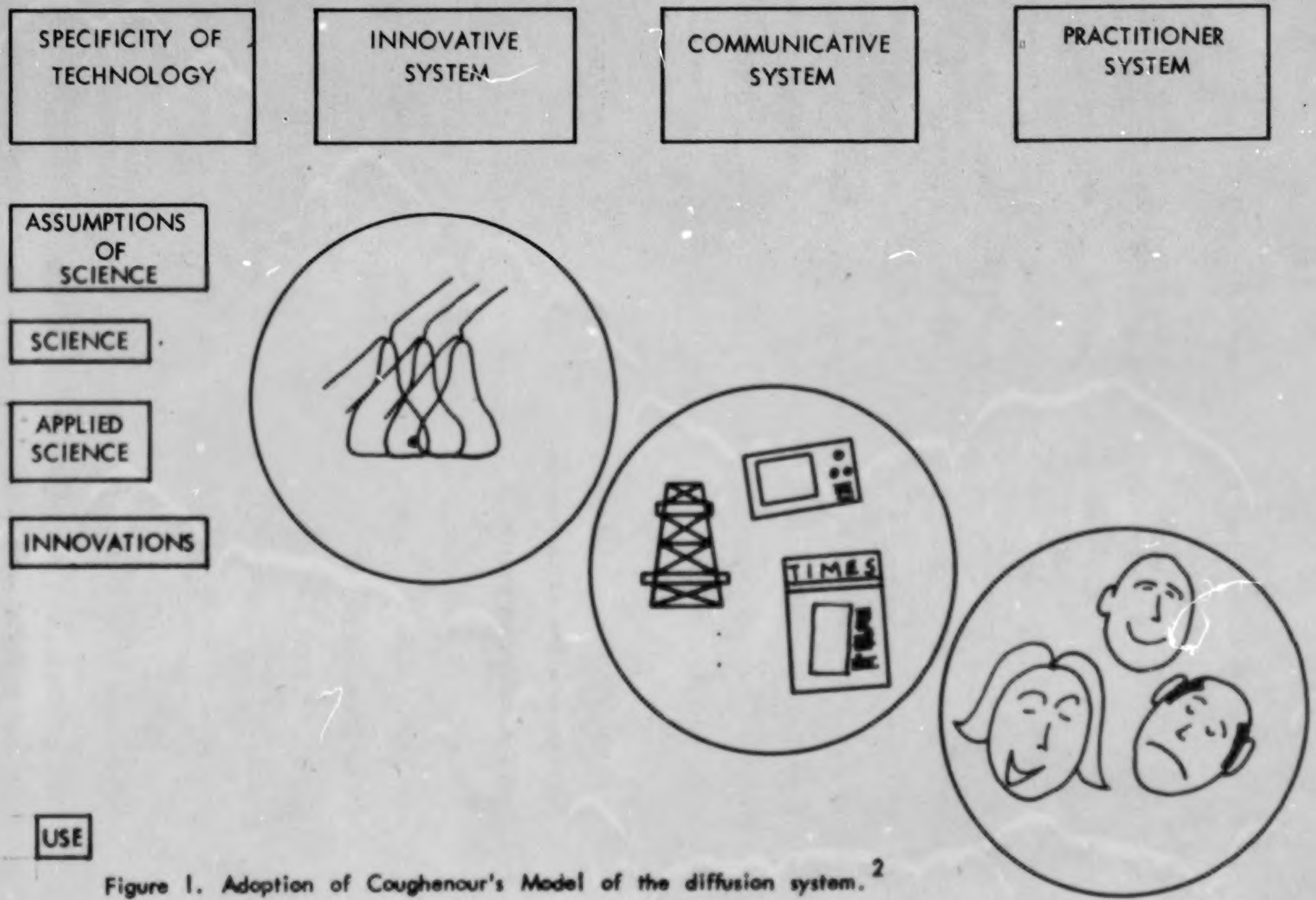

Figure 1. Adoption of Coughenour's Model of the diffusion system.[2]

general system are three important subsystems: innovative, practitioner, and communicative.

Innovative Subsystem The essential question to ask at this point is from where do new ideas emerge? American mythology emphasizes Yankee ingenuity and creates images of the lonely eccentric inventor. If that image were ever accurate, it is now certainly outdated. Today most innovations emerge from organizations which were established for that purpose: universities, "think tanks" and research institutes, industrial and governmental research laboratories. In fact, it has been suggested that the greatest "invention" of the last two centuries has been the invention of the process of invention. In the United States and other western countries, we have institutionalized the creative process. Partly it was forced upon us by the very complexity of the science and technology we had previously created. Although some innovations still are generated outside the research and development "establishment," this is not the general case. And even when innovations do so arise, they must generally be subjected to further research and development within the establishment before they can be widely used.

Practitioner Subsystem The counterparts of innovators are practitioners — those individuals and social organizations that can use and apply the new ideas. We will later speak at some length about the characteristics of practitioners and how these characteristics affect the diffusion process. For the moment let us mention just one factor: we tend to think and often behave as if practitioners are isolated individuals. This is inaccurate. Rather, the practitioner system is highly organized with many social ties, and these ties have much to do with the way innovations are accepted, modified, or rejected by their potential users.

Communicative Subsystem/System - If we examine the kinds of changes that have occurred in the diffusion system since neolithic man began creating much of technology we're using today, two factors dominate our view. There has been an acceleration in both the rate at which new ideas are created and in the rate at which they spread. It probably took centuries for neolithic man (or more likely, woman) to domesticate wild grains such as wheat, barley, and rye. And it took something like 3,000 years for the innovations and agricultural systems they necessitated to spread from their point of origin in the Middle East through all of Europe. In contrast, hybrid varieties of zea maize were developed and tested during a period of about 30 years and, once developed, completely diffused throughout the United States during a period of less than 25 years.

We already discussed the changes which bring about the rapid development of innovations. We have rationally organized the innovative system. Now we do not depend on the chance that we will stumble onto new ideas; rather we have set up organizations whose purpose it is to create new ideas.

The other change has been the vast elaboration and formalization of the communicative system. The ideas of neolithic man did spread. They were communicated. But the process was informal and happenstance. They spread by word of mouth from village to village and tribe to tribe. And they were pushed along by wars and conquest. Under certain conditions, this informal diffusion network can function fairly efficiently. For example, following the discovery of the Americas, many agricultural crops were exchanged between the eastern and western hemispheres. Corn (*zea maize*) from Central America was introduced into Africa and, without any particular determined effort on anyone's part, spread throughout the continent in a period of about 100 years. But usually the "natural" communication process isn't so fast.

So, just as we've created social organizations to develop new ideas, we've created social organizations to communicate them to others. And this communication process has been enhanced through the invention of many technical means for multiplying and speedily conveying our messages.

Perhaps the most dramatic change in the communicative system began when Guttenberg invented a system of movable type and converted his wine press into a device for printing multiple copies of books. But although the invention of printing had fairly immediate and far-reaching impacts on an intellectual elite, its effects upon the masses of people were at first quite indirect. Mass communication is a product of the nineteenth and twentieth centuries and until recently has been limited to industrialized countries. Newspapers became a mass circulated media when the steam engine was harnessed to the printing press and entrepreneurs such as Benjamin Day developed a sensational journalism that large numbers of people purchased at a penny a copy. And it wasn't until the 1890's that newspapers and magazines achieved virtually universal penetration of American homes. Other media of mass communication, movies, radio, and television, are products of the twentieth century. Movies came in about the turn of the century; commercial radio began in the 1920's; commercial television (after earlier false starts) diffused throughout the United States during the 1950's.

In addition to creating mass media technologies that can multiply messages and convey them to numerous individual practitioners, we have also created formal organizations whose purpose it is to advocate and promulgate social change. Evangelical churches were probably among the first of such change agencies. In the secular world, we find the sales organizations of commercial firms. And we also find governmental and private agencies built to promote specific changes. University extension service (created during the first two decades of the twentieth century) were among the first of the governmental change agencies. Incidentally, extension services have served as the model for most other change agencies, governmental and private, which have been created in the U.S. and are now being created throughout the world.

Levels of Specificity of Technology   As innovations move from innovative to communicative to practitioner systems, the bundle of ideas which comprise the innovation are adapted and reemphasized to meet the concerns and levels of sophistication of those dealing with them. Nearly all specific technologies being promoted today are rooted in a basic set of assumptions about the nature of man and other phenomena and the interaction between the two. The peculiar world view of the scientist can be traced back at least to the Renaissance period and, properly, we should probably begin with the Greek philosophers. The next level of technology is rooted in the specific disciplines of basic science such as chemistry, physics, biology, and the body of knowledge associated with these. It next moves to the level of applied science, such as medicine or agronomy. These applied sciences are generally grounded in several of the general disciplines and attempt to apply general theories to pragmatic problems. Innovations are the result of their efforts. And, of course, innovation, as perceived by the applied scientist, is generally quite far removed from the innovation perceived and used by the practitioner. In general, the movement is from the general to the specific. In the process, certain aspects of the "idea bundle" associated with the innovation get dropped. Others become sharpened and new dimensions, not originally conceived by the scientist, may be added. This change occurs because each group must adapt the innovation to meet his own needs and ends. If the innovation is not to severely disrupt the system, it must be made compatible with other elements in the system. It must be made to fit existing belief, knowledge, and value systems.

Changes as Innovations Move through the Subsystems It requires considerable time, of course, to move across the diffusion system and to translate very general ideas into specific innovations. Interestingly, until quite recently, the major delays occurred within the innovative system. Perhaps a couple of anecdotes will illustrate this time lag.

First let's examine the case of the first antibiotic drug — penicillin. Like other scientific innovations the development of penicillin is rooted in the basic assumptions of science and, as we've already noted, these go back at least to the Renaissance period. And the discovery of the antibiotic depended upon the peculiar way of seeing things supplied by the germ theory of disease. This theory, a product of the general flowering of biological sciences, was formulated and demonstrated by Louis Pasteur and others in the late 1800's. In 1928, an applied scientist, bacteriologist, and physician Alexander Fleming, working in Britain, noticed a mold that inhibited the growth of other microorganisms.

The mold had accidently contaminated a petri dish used in one of his experiments. He found that a broth prepared from the mold had little effect on white blood cells and did not injure animals when injected. This led him to suggest to his scientific colleagues that the substance might be used effectively to dress wounds. His announcement met with thundering silence. By 1932, even Fleming had abandoned his line of investigation. It wasn't until World War II, and the extensive search then underway for new drugs to treat wounds, that Fleming's ideas were resurrected. Bacteriologists and chemical engineers in the United States supplied further refinements, making large-scale production of the drug feasible. Introduced into the military medical services during the later stages of the war, penicillin's effectiveness in treating certain bacterial infections was highly visible. It was soon hailed as a "wonder drug." However, it wasn't until about 1950 that penicillin received nearly universal acceptance among American physicians.

Another example of innovation and diffusion involves hybrid seed corn. In tracing this innovation, we would like to examine the groups involved in developing, communicating and using it. And we would like to examine the way perceptions of the innovation changed as it passed from one group to another (see Fig. 2).

As was the case with penicillin, hybrid seed corn was rooted in the basic assumptions of science and the flowering of biological sciences during the 1800's. In a broad sense, the innovation is based on Darwin's evolutionary theory, published in 1856. It is a more direct application, though, of the genetic theory proposed by Gregor Mendel, an Austrian monk. Mendell announced his theory, supported

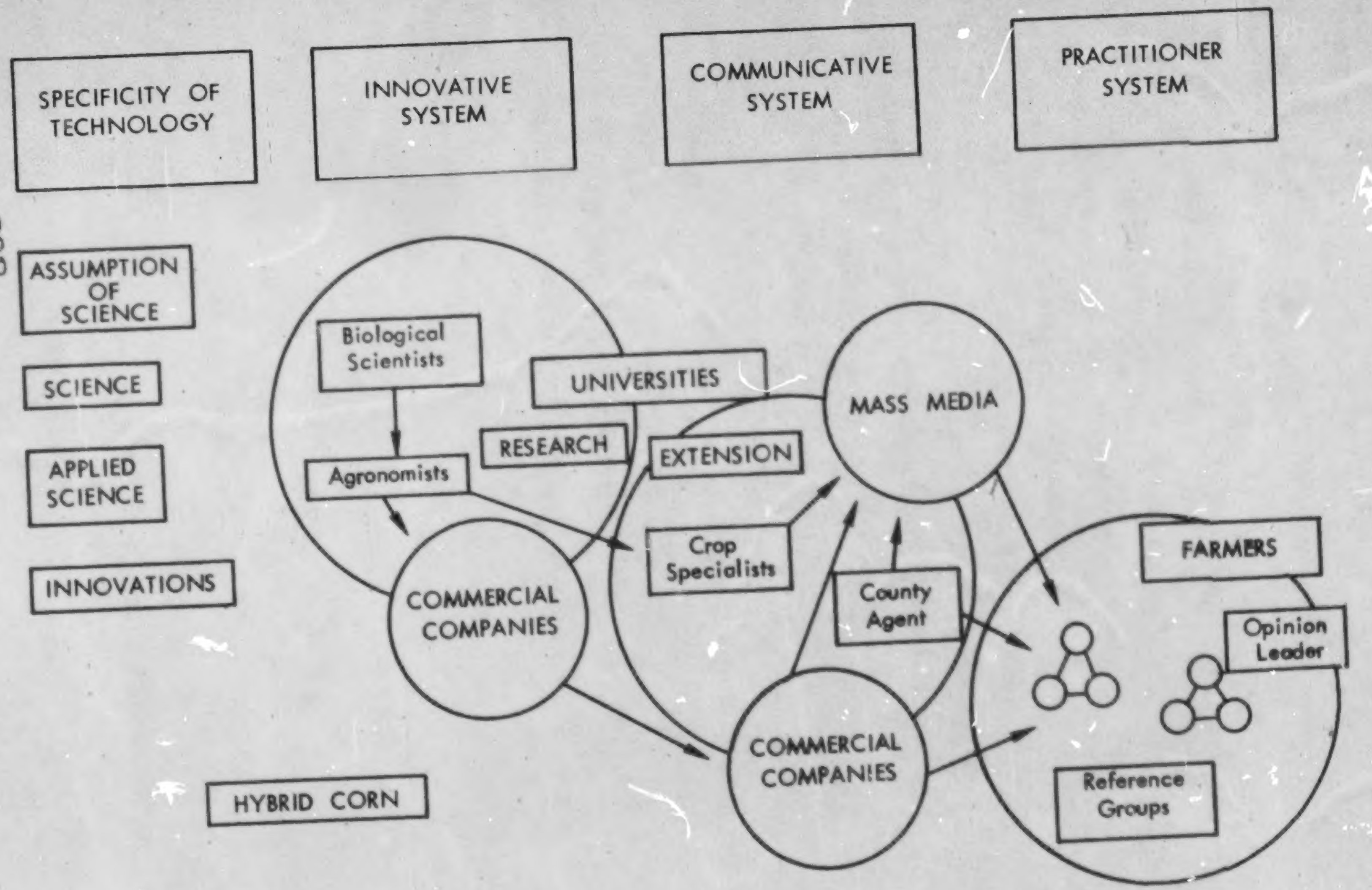

Figure 2. A model of the diffusion system showing the major elements involved in the diffusion of hybrid seed corn in the United States.[3]

by extensive experimental data, in 1865. Like Fleming's later discovery, it was ignored. Subsequently, Mendel became an administrator of his monastery and abandoned his research. In the 1890's his work was rediscovered by plant scientists working to develop improved varieties of crops. Corn (zea maize) was one of the first crops to be hybridized following the laws of heredity. By 1928, the innovation was deemed sufficiently developed for general release. Land grant universities were quite instrumental in developing this innovation. Within the university, both general scientists (mainly botanists) and applied scientists (mainly agronomists and plant pathologists) contributed. The land grant college, through its extension service, also played a major role in diffusing the innovation. An extension service is comprised of a series of linkers who successively translate the products of general and applied scientists to the understandings and needs of the practitioners. The pattern found at Iowa State is typical. The initial linker is a "state subject-matter specialist," in the case of hybrid seed corn, a professional agronomist. This specialist, who is a member of the same academic department as the researcher, and who has regular contact with him, begins the translation. Sometimes he writes bulletins and articles (usually with the assistance of an agricultural journalist) that are conveyed to practitioners through some form of mass media. Sometimes he talks directly with farmers in short courses and conferences. More often, however, he communicates with other communicators such as county agents and representatives of the mass media who do further translation and further conveyance.

As the innovation of hybrid seed corn passed from one system level to another, there was a change in the way it was perceived. The basic scientists were probably little concerned with the practical applications of their discoveries. Rather, they were concerned with the intricacies of genetic coding and with finding general theories through which they could bring order, explanation, and prediction to a chaotic natural world. The agronomist, while still knowledgable about and concerned with these general theories, added a series of practical concerns. He asked, how can I use knowledge of these general laws to make a plant that is more productive, that is more disease resistant, that has a more desirable product? The farmer's conceptualization was more immediate and pragmatic. He understood primarily because it had been demonstrated to him that if he changed the seed he put into his planter hopper, his yields would be increased by about 25%. Even today few farmers have even a rudimentary understanding of how and why the innovation of hybrid varieties works.

We should also mention that commercial companies paralleled the efforts of universities to develop and communicate hybrid seed. They developed their own sales force, organized demonstrations, published pamphlets, gave speeches, talked to individual farmers, and used the mass media in much the same way as did the extension service. Thus, farmers were receiving messages about the same new idea through multiple channels from multiple sources. These messages and channels, in general, tended to buttress one another.

We now turn to the mass media. In the United States, this is a highly complex system. There are about 9,000 weekly newspapers, some

1,750 daily newspapers, and more than 5,000 radio and 700 television stations. There are literally tens of thousands of magazines (no one is quite certain exactly how many). Most of them tend to be quite specialized and serve the needs of nearly any kind of group or interest. One directory lists more than 350 publications aimed at farmers. The titles reflect the varied interests served: Almond Facts, Cow Country, The Wool Bag, The Spudman, Turkey World.

But the communication process does not end when the governmental and commercial "change agents" have talked with farmers or when they have conveyed their message through one of the mass media. Rather, research shows that additional communication and translation and modification of the innovation usually occurs within the practitioner system. Hybrid seed corn was no exception to this pattern. Farmers talk to other farmers. They visit one another and observe each other's farming practices. Over time, certain of the farmers come to be more respected than others among their peers. What they say and do assumes inordinate weight among their peers. They become opinion leaders. The leaders and their followers become organized into informal reference groups. They interact on a continuing basis. And the interaction becomes valued in and of itself. Potentially, any innovation could disrupt these patterns of interaction and destroy the affectual bonds among the farmers. For this reason, the new idea must be legitimized into the ongoing belief and value structure. (Incidently, research shows that the notions of reference groups, opinion leadership, and legitimization of innovations apply to other groups in much the same way as they do farmers. Most people, be they janitors, physicians, or college professors, are influenced inordinately by reference group norms and the opinions of their peers.)

Comparison with the Diffusion System in Developing Countries If we compare the diffusion system as it operated for hybrid seed corn in the United States with that generally found in developing countries, what are the similarities and differences? At the risk of overgeneralization, here's what we see from personal experience and reading the descriptions of others.

First, the innovative system is generally not very different. Most countries have organized and are operating their own research establishment. Though there are exceptions, most are staffed by competent applied scientists, most of whom have received advanced degrees in the United States or Europe. Thus, we have already exported to these countries basic scientific information. In many instances, we have exported specific technologies and innovations that can be applied in such places as Colombia, Ghana, and India as well as they can be applied in the United States. In other instances, scientists in developing countries are adapting western-originated technologies and innovations to local conditions. In short, most developing countries do have a developed, functional innovative system. A major difference, compared to the U.S., is that most of the research is done by the government. Relatively little research and development is being done in the private sector.

If we compare the communicative system of most developing countries with that of the U.S., we see rather large differences, however. In most developing countries, mass media exists within urban areas. But, with the exception of radio, little mass media penetrates into the hinterland. (And, as those of you who have had experience in developing countries know, it doesn't take long to travel from the urban area to the hinterland.) Furthermore, this situation isn't likely to change quickly. Print presumes literacy. It also requires a well-developed transportation and distribution system to move the printed product from the press to the reader. Television receivers are exorbitantly expensive, complex to repair, and assume that electrical power is available. Battery-operated transistor radios, on the other hand, are relatively cheap. They've gained almost universal acceptance.

Most countries have also developed extension services to promote change, but, in general, they aren't effective. The reasons are several. For one, the U.S. model of extension service has been incompletely adopted. In addition to having duties as an educator, the extension worker in many countries is expected to administer government agricultural programs and to enforce government regulations. Educators and policemen are incompatible roles, as welfare workers in the United States have discovered. Another reason that most extension services aren't effective is that they have totally inadequate resources. For example, the agricultural extension service in Colombia has a field staff of only 50. They are to serve a rural population of nearly 10 million living on more than 1 million farming units! Furthermore, the extension workers are generally not trained in education or communication techniques. Few can put on a radio show. And, unlike their counterparts in the United States, they don't have professional journalists to help. In most countries the extension workers have little training in the technical subject matter they are to communicate. Their ties with the innovative system are tenuous at best.

Another difference in the communicative system of most developing countries is the relative absence of a commercial sales force. And generally, there isn't an independent mass media similar to the U.S. farm press and radio to search out and report information which government doesn't want to, or doesn't think about conveying.

The practitioner system is also different. In part, it's a matter of norms. In the United States we've developed a value structure that is pro-innovation and pro-science and technology. In developing countries, just the opposite is usually the case. There is a fear of change and a distrust of those promoting it. And, perhaps most important, traditional opinion leaders in developing countries are generally most resistant to change. They see it, usually rightly so, as a threat to their status. Another factor is that the innovations offered by science and technology assume a belief and knowledge structure that just doesn't exist in most developing countries. For example, we generally accept sanitation practices in the United States. We do so partly because most of us have a rudimentary understanding of the germ theory of disease. We can understand the rationale for the practice. In developing countries, this understanding is lacking. So is the sanitation.

Other Adoption-Diffusion Concepts

Coughenour's diffusion system model provides us with a convenient holistic framework, but the intricacies of diffusion, and especially the part that practitioners play in it, can be better understood through some additional concepts.

Innovations, Adoption Units, Behavior One set of concepts are those related to (1) the characteristics of the innovation, (2) the characteristics of the decision-making unit which will actually use the innovation, and (3) the kind of adoption behavior in view. These concepts are outlined in Fig. 3.

Obviously these factors are interrelated. For example, individuals cannot make an autonomous decision to adopt water fluoridation. Under present technology, this innovation is not divisible. Either the entire community's water supply is fluoridated, or none is. The decision to implement this action must either be made by some group with authority (e.g., a city council), or cast into a larger community decision-making process such as a voter referendum. In short, the individual's acceptance of the innovation is constrained by the group. Other innovations, for example, a fluoridated toothpaste, can be adopted by the individual without reference to others. The innovation is divisible, easily and cheaply tried, and is not highly restrained by other behaviors[4].

If we are interested in affecting the adoption behavior of individuals, the variables of concern are attitudes, beliefs, and personal situations. If the adoption unit is a group, we are additionally concerned about such factors as the power and authority structure of the group and the goals of the group. Large systems, such as a community, may be best conceived as systems of systems. And, if we are attempting to secure adoption by such a decision-making unit, we have to be concerned with such variables as system linkages, boundary maintenance, and the unequal distribution of power among the actors.

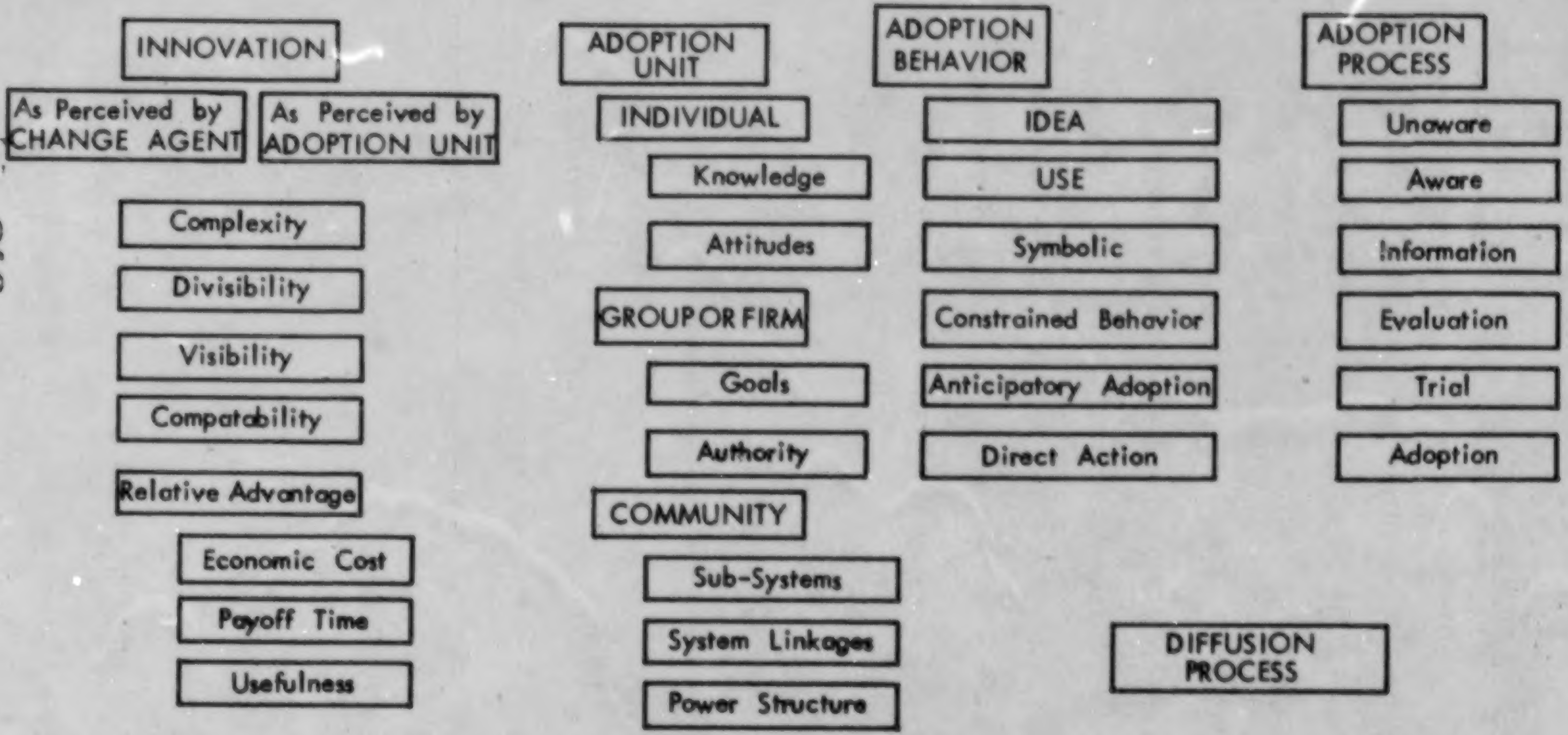

Figure 3. Characteristics of innovations, adoption units, adoption behavior and adoption process.

Adoption vs Diffusion Processes   Perhaps we should formally state the distinction between adoption and diffusion which we hope has been implicit in what we've previously said. When we speak of diffusion, we are referring to the process and mechanisms by which an innovation spreads through a system. Our unit of analysis is the system rather than the individual. When we speak of adoption, we refer to the decision-making process through which individuals become aware of and act upon new ideas. Research shows that the adoption process for innovations of significance is not a unit act. Rather the decision-making process extends over a considerable time period and involves a number of steps. One model hypothesizes five distinct stages. First, there is creation of awareness that an innovation exists. Second, there is an interest arousal and information gathering stage at which the individual acquires details about the new idea. Then there is an evaluation or mental trial when the individual asks, "Will it work for me?" If the answer is "yes" and the innovation is divisible, the individual usually proceeds to try the innovation on a small-scale basis in his own situation. If the trial is satisfactory, full-scale adoption may follow.

As we've said, research indicates that for innovations of major consequence, people usually go through a process in this general order. In some cases, there is vascillation between the stages, especially between information gathering and evaluation. For one of the outcomes of evaluation may be, "I need more information."

If the innovation is cheap and is not of major consequence, for example, a new brand of toothpaste, we may proceed directly from awareness to trial. The trial serves as the major information base and serious evaluation for continued usage follows the trial. But we assume that this seminar is concerned with things of greater consequence than the decision between two brands of toothpaste.

Time Lag in the Decision-Making Process It perhaps comes as no surprise to you that research finds that some people adopt things faster than do others. They do for two reasons: 1) They become aware of the innovation earlier because they are tuned into the communication networks that promote the innovation, and 2) they require less time to reach a decision. When we examine the time at which different people accept new ideas, we discover some rather systematic relationships. One discovery is that many innovations tend to diffuse at a rate approximating an S-shaped (ogive) or (viewed another way) a bell-shaped curve. At first, the rate of acceptance is quite slow. There is then an acceleration and most people adopt the innovation within a relatively short time span. Then there is a slowing down of the process, and the last adopters trail out over quite a long time period. Researchers have arbitrarily divided the diffusion curve into standard deviation units, and have examined the characteristics of people falling into the categories. And we've given them names, and drawn their pictures (Fig. 4). The first two and a half percent of the population to adopt are called *innovators*. The next group (who comprise about 13-1/2 percent) are the *early adopters*. The early majority, late majority, and late adopters or laggards follow.

Innovators tend to be scientific and venturesome. Late adopters tend to believe in agricultural magic, folk beliefs and have a fear of debt. Other characteristics of the adopter types are outlined in Fig. 5.

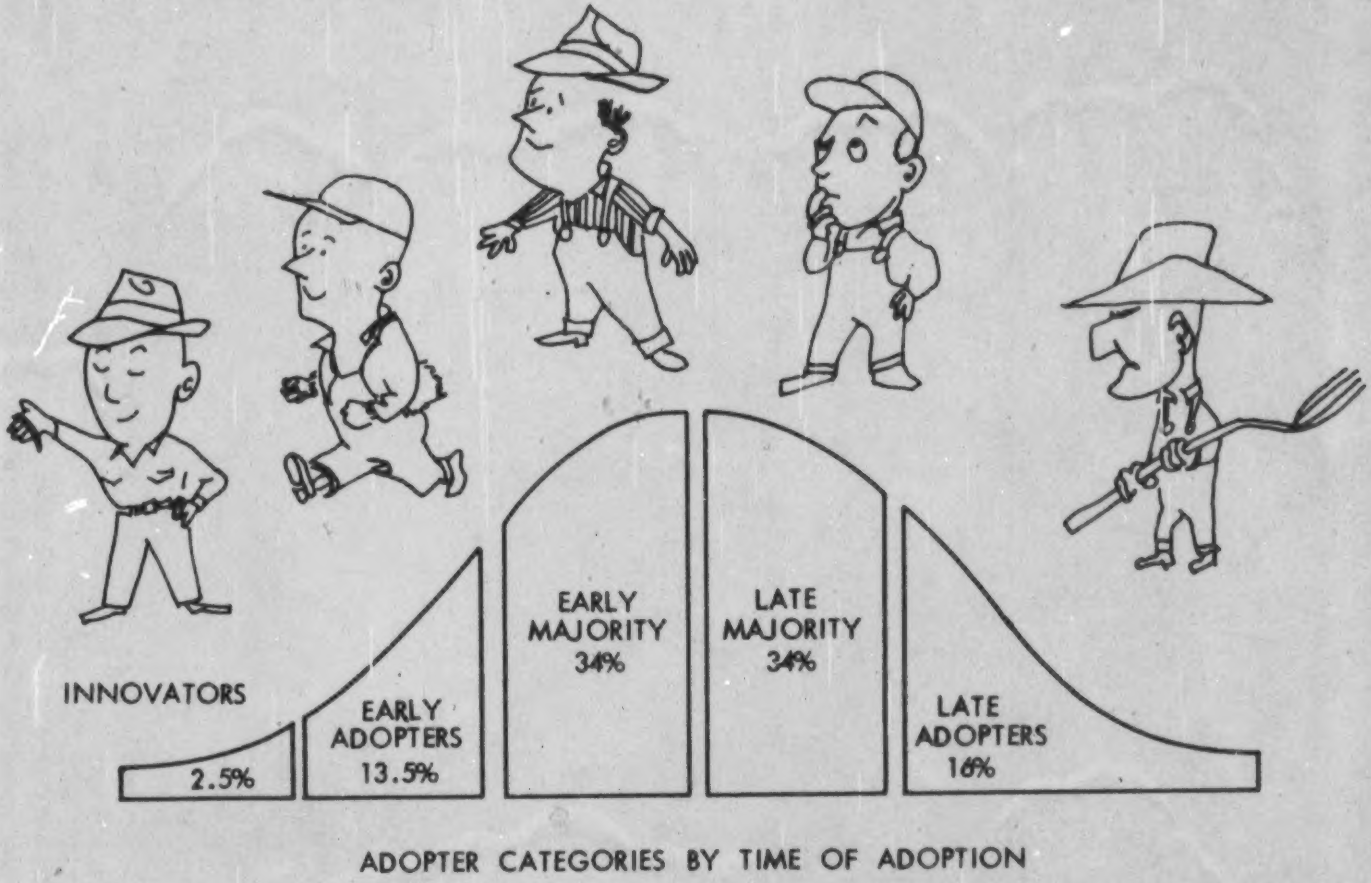

Figure 4. Adopter categories by time of adoption.[5]

Characteristic or Behavior	Innovators	Early adopters	Majority		Laggards or Late adopters
			Early	Late	
1. Time of adoption	First 2.5 per cent to adopt new ideas	Next 13.5 per cent to adopt	Next 34 per cent to adopt	Next 34 per cent to adopt	Last 16 per cent to adopt
2. Attitudes and values	Scientific and venturesome	Progressive	More conservative and traditional	Skeptical of new ideas	Agricultural magic and folk beliefs; fear of debt
3. Abilities	High level of education; ability to deal with abstractions	Above average education	Slightly above average education	Slightly below average education	Low level of education; have difficulty dealing with abstractions and relationships
4. Group memberships	Leaders in county wide or state organizations; travel widely	Leaders in organizations within the community	Many informal contacts within the community	Little travel out of community; little activity in formal organizations	Few memberships in formal organizations other than church; semi-isolates
5. Social status	Highest social status, but their farming practices may not be accepted	High social status; looked to by neighbors as "good farmer"	About average social status	About average social status	Lowest social status
6. Farm businesses	Largest, most specialized, and most efficient	Large farms; slightly less specialized and efficient	Slightly larger than average sized farms	Slightly smaller than averaged sized farms	Small farms; low incomes; seldom farm owners
7. Sources of information	Scientists; other innovators; research bulletins	Highest contact with local change agents; farm magazines; Extension bulletins	Farm magazines; friends and neighbors	Friends and neighbors	Mainly friends and neighbors; radio farm shows

Figure 5. Summary of characteristics and communication behavior of adopter categories.[5]

The diffusion of 2,4-D weed killer illustrates several of the ideas we've been discussing (Fig. 6). This innovation was introduced in 1944. Within three years slightly more than half the farmers in Iowa were aware of it, but only 10 percent had adopted it. By 1950, virtually all Iowa farmers knew of the innovation, and half had adopted it, but it took another five years for the diffusion process to be completed. Late adopters took longer to learn about 2,4-D and

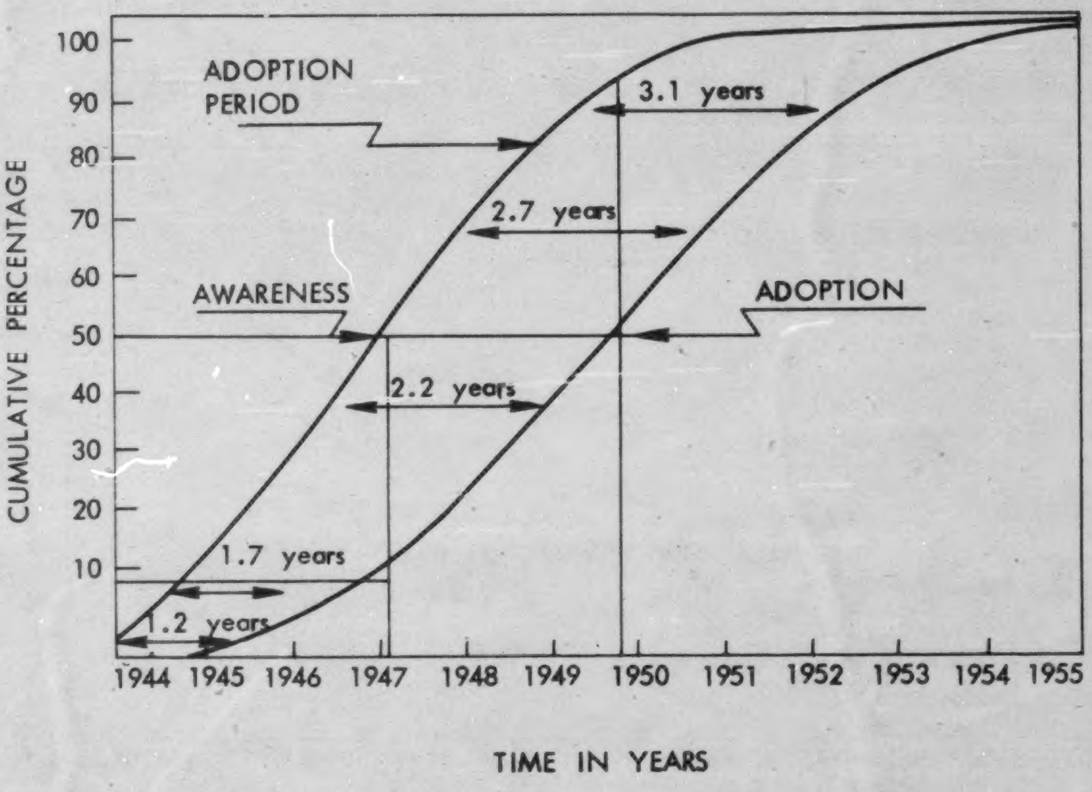

Figure 6. Adoption period for Iowa farmers adopting 2,4-D weed spray by year.[6]

took nearly three times as long to move from awareness to adoption as did the innovators.

Another example of diffusion rate is provided by the awareness and diffusion curves for the pap smear test to detect cervical cancer in women (Fig. 7). This innovation was introduced in about 1950 and 23 years later is not completely diffused. This, despite the fact that it has been promoted by medical doctors, is supposedly the epitome of scientific practitioners.

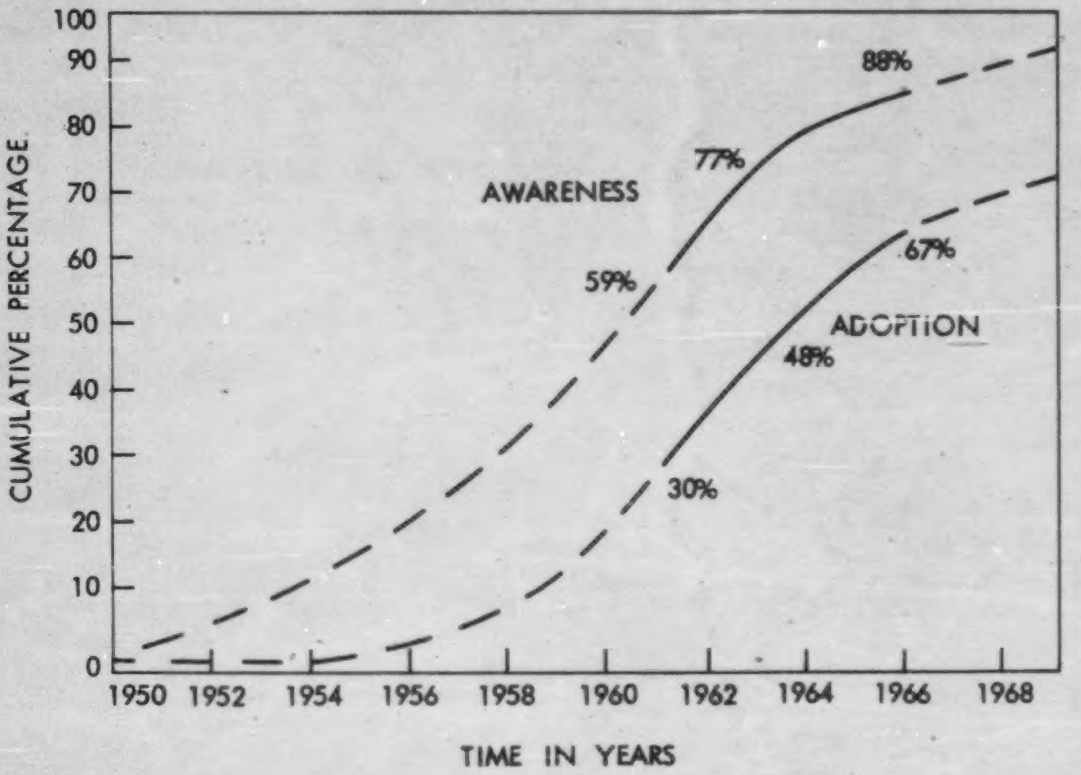

Figure 7. Estimated diffusion of pap test among American women.[7]

Three educational innovations provide other interesting case studies (Fig. 8). It took 50 years to obtain universal adoption of kindergartens in the United States. Driver training started in the 1930's and took about 50 years to diffuse. But modern math was adopted by nearly all school systems during a period of only five years. What accounts for the speed up? Probably two major factors: 1) Since 1910 Americans have probably adopted the notions of innovation and change as a positive cultural value. We are now more receptive to new ideas of any kind than we were in 1910; and 2) modern math was adopted during the aftershock of Russia's launching of Sputnik I. Agencies such as the National Science Foundation actively promoted the innovation and sponsored well-funded programs to retrain teachers.

It is interesting that at the same time we became concerned about school children's math abilities, we also became concerned that "Johnny can't read." But no program to revolutionalize the teaching of language skills ever materialized. There was no agency or significant finance to promote such change. The result: Today Johnny can count, but he still can't read!

Research strongly indicates that, to the extent that an active diffusion system is operating, innovations are accepted much more rapidly. Cross-cultural studies indicate that the most important single variable, among an entire system of variables relating to the rate of acceptance of technological and social change, is the stage of development of the media system within the country.

Information Sources and the Adoption Process Despite the importance of mass media as a system variable, research indicates that its

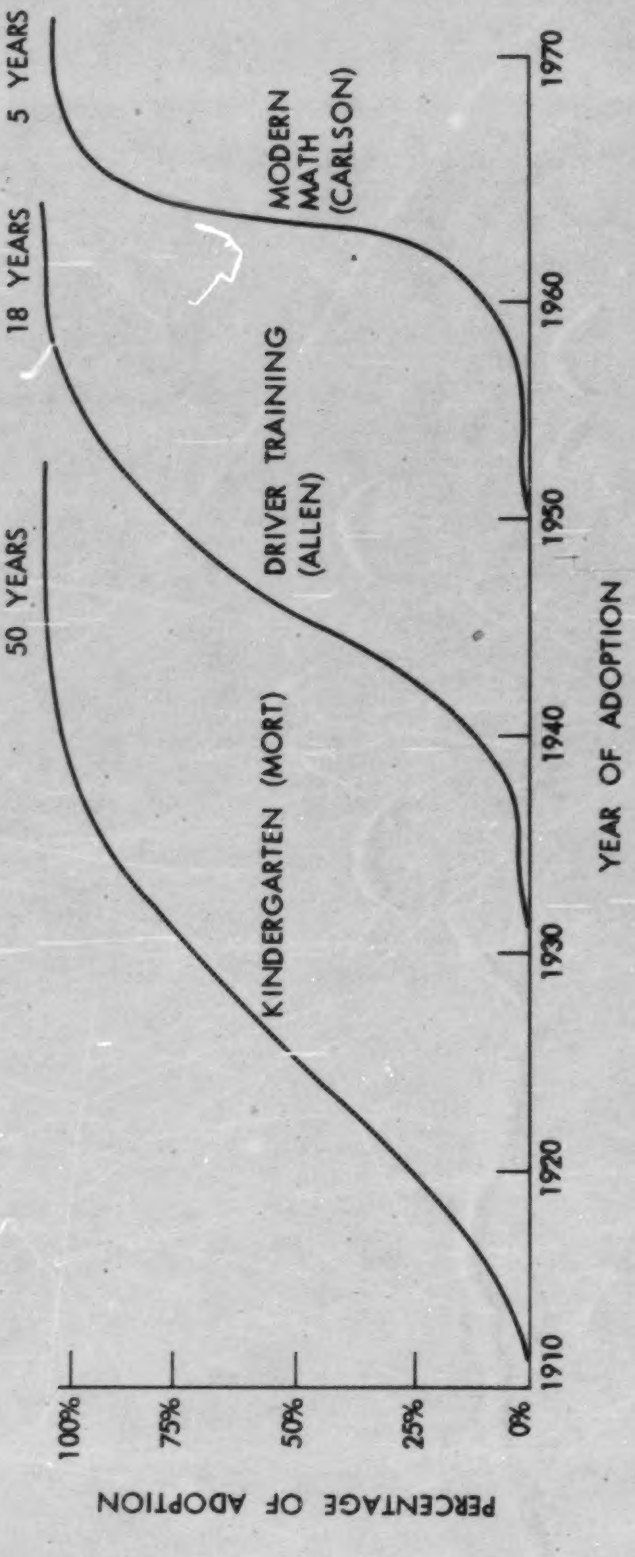

Figure 8. Diffusion curves for three educational innovations.[8]

role in the diffusion process is limited. It is a necessary, but not sufficient, condition. Numerous studies of agricultural innovation diffusion in the United States indicates that mass media are the most important sources of information for creating awareness of and interest in new ideas. Personal communication, especially with neighbors, is necessary before the idea will be accepted (Fig. 9). Our behavior is constrained by the groups to which we belong and by the individuals whose esteem we value. New ideas, whether they are social or technical innovations, must be adapted to and legitimized within this on-going structure.

An example of the pattern of personal influence in the adoption of 2,4-D weed killer is provided in Fig. 10. This map plots the farmers living on a square mile of Iowa farmland and their neighbors. The neighborhood's innovator adopted the weed spray in 1948. His personal referent was an agricultural scientist at the university. Two years later a second farmer adopted. He referred to the innovator. This second adopter then became the opinion leader for most other farmers within the community. A few secondary opinion leaders emerged among the early and late majority as the innovation spread to other farmers. Diffusion was complete in 1956, some eight years after the first adoption. The pattern of not referring to innovators as opinion leaders is the rule, not the exception. In general, innovators are too far ahead of their peers. Neighbors tend to think of them as "nuts." They are deviants from the established pattern. Though they can help bring new ideas into a community, they are not generally very effective in spreading these ideas to their neighbors.

AWARENESS:	INTEREST:	EVALUATION:	TRIAL:	ADOPTION:
LEARNS ABOUT A NEW IDEA OR PRACTICE	GETS MORE INFORMATION ABOUT IT	TRIES IT OUT MENTALLY	USES OR TRIES A LITTLE	ACCEPTS IT FOR FULL-SCALE AND CONTINUED USE
1. MASS MEDIA -- RADIO, T.V., NEWSPAPERS, MAGAZINES	1. MASS MEDIA	1. FRIENDS AND NEIGHBORS	1. FRIENDS AND NEIGHBORS	1. FRIENDS AND NEIGHBORS
2. AGRICULTURAL AGENCIES, EXTENSION, VO-AG, ETC.	2. DEALERS AND SALESMEN	2. DEALERS AND SALESMEN	2. DEALERS AND SALESMEN	2. DEALERS AND SALESMEN
3. FRIENDS AND NEIGHBORS -- MOSTLY OTHER FARMERS	3. AGRICULTURAL AGENCIES	3. AGRICULTURAL AGENCIES	3. AGRICULTURAL AGENCIES	3. AGRICULTURAL AGENCIES
4. DEALERS AND SALESMEN	4. FRIENDS AND NEIGHBORS	4. MASS MEDIA	4. MASS MEDIA	4. MASS MEDIA

PERSONAL EXPERIENCE IS THE MOST IMPORTANT FACTOR IN CONTINUED USE OF AN IDEA

Figure 9. Rank order of information sources by stage in the adoption process.

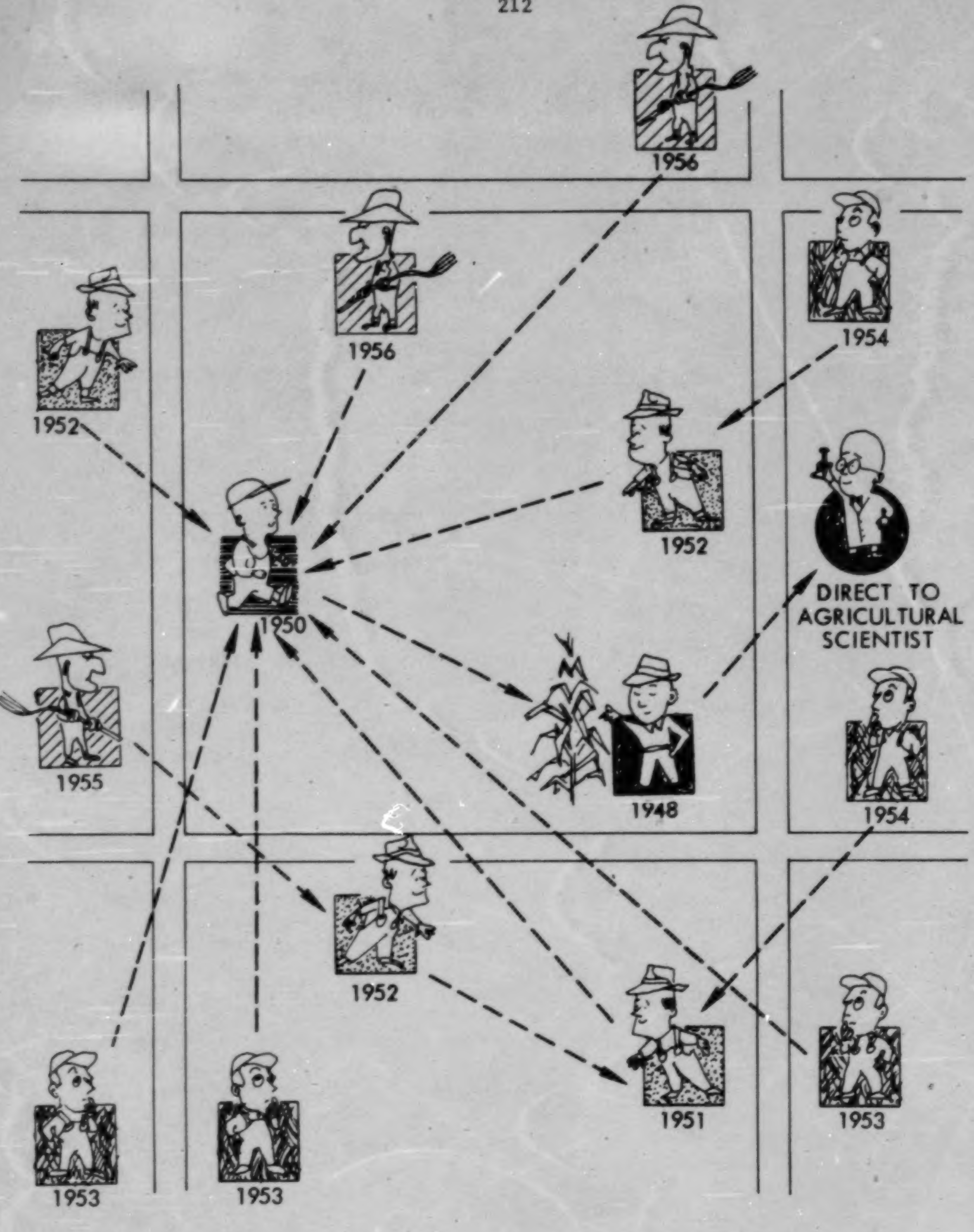

Figure 10. How fourteen Midwest farmers obtained information on a new farm practice. Farm locations are shown against a mile grid.[5]

The patterns of personal influence illustrated by farmers and 2,4-D are quite representative of research findings on other topics and among other occupational groups. Similar patterns are found among physicians and dentists in adopting new health care practices. And the same patterns are found for the way school teachers and housewives accept new ideas.

Application in Cross-Cultural Settings The generalizations we have presented have been derived primarily from the study of diffusion of innovations among occupational groups in the United States. They have primarily involved innovations that worked; they delivered in some tangible way what they promised to deliver: more profit, a better cure, an easier solution.

Are the generalizations applicable in developing countries?

The data needed to answer this question is far from complete. But the initial answer is "Yes, with slight modifications." Acceptance of technology in developing countries is inhibited by a lack of understanding of basic concepts behind it, by inadequate and ineffective communicative systems, by general system norms inhibiting change, and by an entrenched leadership structure whose status is threatened by the change. Maybe this is good. The changes that are accepted usually prove to be even more disruptive to these societies than they are to our own. And the benefits of the change are often, perhaps generally, inequitably distributed.

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7. American Cancer Society surveys.

8. Figure adopted from Rogers and Shoemaker, *Communication of Innovations*. Data on Kindergarten Diffusion from Paul R. Mort, "Educational Adoptability." Driver Training Diffusion is from Harley E. Allen, *The Diffusion of Educational Practices in the School Systems of the Metropolitan Study Council*. Diffusion of Modern Math is from Richard O. Carlson, *Adoption of Educational Innovations*.

IMPACT OF MODERN MEDICINE AND BIOLOGY IN DEVELOPING NATIONS

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THE IMPACT OF MODERN MEDICINE AND BIOLOGY IN DEVELOPING COUNTRIES

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Technology has diminished the importance of time and distance and has vastly increased our capacity for mass destruction. Consequently, we are increasingly aware that we are members of the world fraternity with one factor in common; the fact that we are all human. The human desire for, and more recently the right to health is universal. Because of this, the technology of medicine in developing nations meets few objections or barriers on principle alone. Transcending all barriers of race, creed, color, politics, status, friend, and foe, the ethic and philosophies of medicine have professed reverence for life, and from this stems its acceptance.

Today, when three jet aircraft containing up to 500 passengers each are processed every half hour through one airport, the potential for spread of communicable disease staggers the imagination. It is now recognized by all that the only way of preventing the old plagues and some new ones from spreading from continent to continent and from country to country is for the rich nations of the world to help the poorer nations reach such a level of economic and technical development that the evil can be combatted at its source.

How will our success or failure be measured? The number of people cured of a disease? Mortality rates? Survival rates? These are obviously inadequate because population increase can obliterate the significance of these traditional measurements of a nation's health.

But an individual physician is overjoyed to be able to save one life, pleased to cure one illness, grateful to be able to relieve one pain. These simple successes can, but should not be inundated by a flood of pessimistic statistics.

History of International Health Organization

The earliest medical problem to become the concern of more than one government was the prevention of epidemics spreading from one country to another. Several international organizations were formed in the 1800's and early 1900's for the prevention of communicable diseases and to make regulations for quarantine and world shipping. Following World War I, in various organizational steps the League of Nations formed a General Advisory Health Council to the League Health Organization which functioned until World War II, predominately in the fields of epidemiology and technical studies. As the international political situation worsened from 1936 on, and with the decline in the League's influence, repercussions were felt directly upon the Health Organization, so that during World War II only a skeleton staff persisted in Paris.

In September 1941, the first stages for the development of a post-war health organization were undertaken, which, in November 1943, led to an agreement signed by forty-three allied and associated nations establishing a United Nations Relief and Rehabilitation Administration (UNRRA). The purpose of UNRRA was predominately to restore health services in nations ravaged by war, prevention of epidemics, and the administration of regulations for international sanitary control. UNRRA functioned in this capacity with various successes, the most notable of which were the prevention of typhus and cholera epidemics and the beginning of malaria control on an international basis. Much of the medical care of the millions of displaced persons in Germany, Austria, Italy and the Middle East was provided for under the control of UNRRA.

In 1946, at a World Health Conference in New York, the constitution of the present World Health Organization was signed, with arrangements for the establishment of an Interim Commission until the constitution came into force. The permanent organization came into being in 1948, and absorbed the rump organization of the League of Nations as the Interim Commission had taken over the work of UNRRA. In addition to the World Health Organization, an agency of the United Nations, the Food and Agricultural Organization, and the United Nations Childrens Fund (UNICEF) all have functions in the international health field in developing nations.

There are also many voluntary agencies serving in somewhat different capacities. The various internationally-funded organizations such as Leagues against Tuberculosis, Venereal Diseases, Cancer, the League of Red Cross Societies, and many religious groups which are international in character contribute greatly. The United States has the Rockefeller Foundation and the Unitarian Service Committee of America; the United Kingdom has the Save the Children Fund. CARE-MEDICO is funded and staffed by Canadian-American voluntary contributions and personnel. The Friends Service Council has been extremely active in health work, especially in areas involved in hostilities. And, of course, there are many bilateral aid agreements between nations which provide medical assistance.

What Is Health and How Can It Be Provided in Developing Nations?

Health can be defined in its widest connotation as "bodily and mental well being, wholeness, and moral or spiritual soundness." The World Health Organization defines health as "a state of complete physical, mental and social wellbeing." In the early days after World War II, the emphasis of the larger international health organizations in developing nations was on control or eradication of communicable diseases, with special emphasis on malaria, tuberculosis, and venereal disease. Many of these programs have continued with varying degrees of success.

By 1968, malaria had been eradicated from countries inhabited by 648 million people, and controlled to various degrees in areas inhabited by 711 million. It has been eliminated from all of Europe, the Asian part of the Soviet Union, Israel, Lebanon, Syria, and neighboring countries in the Middle East, from large parts of India and Ceylon, Japan, from most of North America (including all of the United States), most of Venezuela, and the southern portion of Australia. Deaths due to malaria had decreased from 2.5 million annually to below one million annually. There were, however, serious reverses. In Ceylon where the eradication control program was almost completed a serious epidemic occurred in 1967 and 1968, with more than one million cases. There have been difficulties in Pakistan and in India also, despite tremendous expenditure of resources in the malaria program.

Between 1966 and 1969, the incidence of small pox declined sixty percent due to massive immunizations. This has continued to decline; so that in many developed nations, where the incidence of the disease is close to zero, immunizations for small pox are not considered necessary. Massive efforts for the treatment of syphilis and yaws with penicillin were undertaken. Various methods of detection, treatment and follow-up were devised; however, syphilis is presently increasing in many countries.

We are now in the twelfth year of a cholera pandemic which has resisted all efforts at control, although treatment of the disease itself has vastly improved the mortality rate. Because of the widely varying degrees of success of these massive programs for communicable disease control, questions were raised early in the post-war period as to priorities to achieve maximum health in developing nations with the resources available.

In the determination of priorities for a health program, this question, which is in conflict with all basic ethics of medicine, must be raised: What, of what can be done, should be done? Of what can and should be done, what can we afford? What, of what we can afford, are we prepared to pay? Some of the failures of the disease control projects can be related to the failure to answer these questions adequately before embarking. It was found that eradication of malaria became impossible in some countries because of the shortage of basic health services and administrative and financial obstacles, so that lack of follow-through and hygienic improvement caused relapses and further epidemics. Moreover, a program limited to one country, surrounded by others where eradication was not undertaken, was doomed to failure.

Thus, it was found that social, political, and economic forces could not be separated from the technologic advances in the improvement of a nation's health. Medicine which merely controlled disease was no better than a farm where nothing was done but destroy weeds. Those countries where diseases had been controlled most successfully were found now to have the greatest fear of over-population. The quality of life and not quantity of lives needed to be emphasized.

Recognizing the need for change, the 24th World Health Assembly, in 1971, decided it would focus its attention on: A) The strengthening of health services, the single most important factor for the attainment of the highest possible level of health in any country; B) the development of health manpower, considered to be the most complicated element in health programs and the most essential; C) disease prevention; and D) promotion of environmental health.

The major health problems in developing nations are different from those in the developed world. Because of the combined impact of malnutrition and repeated infections in the intestinal tract, the death rate is highest below the age of five. In the developed countries where nutrition and sanitation are good, health services predominantly deal with chronic and degenerative diseases of the aging population. Between 1965 and 1968, the population of the world increased by 250 million, most of this increase was in the developing countries. Different diseases and different populations require different health services, personnel, and priorities.

An example of these differences is found in West Cameroon where one half of the population is under the age of 15, and children below five years constitute 20 percent of the population. The infant mortality rate is 138 per thousand. Children still die in vast numbers from communicable diseases. Because of the lack of development of transportation and communication, the distances involved present a serious health problem and the environment is a major contribution to infant mortality. There is a doctor:population ratio of 1:32,000. Malnutrition is the principal problem of child health in the country, and when combined with infection, represents the major cause of death under the age of five. Sickle cell anemia is a common problem with up to 1.5 percent of all children affected.

Nutrition, Sanitation Methods and Medicine

Protein and calorie malnutrition is the most serious nutritional problem in relation to public health confronting the developing countries. Its incidence ranges up to 50 percent of children under the age of five in some nations. Because of the greater facilities where medical care is now available and the better knowledge of treatment, mortality due to malnutrition, is decreasing. However, there are indications that many children saved from death are scarred by the disease, and enter adulthood mentally and physically retarded without being able to contribute fully to the society in which they have survived.

Various food mixtures based on cereals, protein concentrates, and containing about 20 percent protein have been produced for use in areas with chronic protein-deficient diets. One of these, Superamina, was developed in Algeria and has been used extensively. Prevention of malnutrition in rural areas hinges on increasing the production of certain foods and the easing of taboos where practical. However, in a crowded slum the increased capacity to purchase food and a better knowledge of what to purchase must be provided.

The cumulative effect of continuous infections in young children has been realized only recently. A two-year-old child who has had 10 or 20 infectious episodes in a short period may well have been sick more than twenty percent of its life. Frequently another infection is contracted before the loss in weight due to the previous one has been recovered. These infections are caused by lack of elementary sanitation and safe drinking water. Approximately one-half the world's population is without elementary sanitation and hundreds of millions are without safe water.

At the 24th World Health Assembly in 1971, a target date of 1980 was set to provide clean and abundant water in the developing countries for all city dwellers and for 20 percent of the people in rural areas. It was estimated this would cost $7.5 billion for the urban water supply and $1.5 billion for the rural water supply construction. In this respect, education and health are inseparable as none of the advances of adequate nutrition and sanitation methods will be effective without education of the population.

Socio-Economic Relation to Medicine

There are two schools of thought on the relation between health and socio-economic advance. One school believes that eradication of disease leads to individual health and provides an effective lever for economic and social advance. The other school of thought believes that the success of the eradication of disease and maintenance of the program depends on an adequate socio-economic level, and that without this level, no permanent success can be expected.

Medicine is one aspect of social technology, but health depends on a number of factors other than purely medical ones: Nutrition, educational standards, population growth, economic prosperity, etc. Health and human welfare is a two-way equation. Good health is necessary for welfare but it cannot be achieved without certain standards of living. Thus it is inextricably bound up with economics. Public health of a country means the health of its masses, and the masses will scarcely be healthy unless they are at least moderately prosperous to the very base. Medical advances do not arise in a social vacuum. They are products of the scientific knowledge of the time and of the demands of the community. Although concentrated technologic effort may create new methods in medicine, the proper use of these means depends on the society which must have the will, the resources, and the favorable environment to apply the knowledge to the promotion of health. Thomas Parran, former Surgeon General and Chairman of the World Health Conference in 1946, has said, "There are two great drains upon the resources, the manpower, and the accumulation of capital in most countries which detract from human health and well being: Expenditures to provide housing, food, clothing, and other items which are required for normal living by the too rapidly increasing population, and expenditures for war or the prevention of war, defense."

Ecology and Medicine

Technologic assistance in socio-economic development can have both positive and negative influences on total health. For example, schistosomiasis has been a problem in Rhodesia because the intermediate host snails are found in the natural water courses. After World War II the national policy of achieving a high standard of soil and water conservation for predominantly agricultural development began to have another impact. Streams which had previously held water for only a few months during a four month rainy season became suitable environment for host snails throughout the year. In the same time period the population began to increase at a fast rate. Thus, contacts by man with snail habitats increased proportionate to the time exposed, population, and area inundated by dams.

Another example of environmental change and its impact on health is found in the urbanization of millions of persons in Africa, Asia, and tropical America. People living in primitive surroundings, drinking impure water and eating foods exposed to flies become exposed to a variety of illnesses during infancy and childhood. The survivors build a resistance to many of these, including paralytic poliomyelitis. Now, for the first time, large sections of the populations in these areas are being provided with purified water as well as waterborne sewerage and, of course, much greater numbers will have these in the future. It seems likely that the incidence of severe gastroenteritis and dysentery will fall dramatically, as will the infant mortality rate. However, had not an inexpensive vaccine against paralytic polio been developed, large numbers of children and young adults would have been stricken with this disease, causing the added burden of a handicapped segment of the population.

Food-borne infections due to changes in animal husbandry and practical problems in the use of pesticides are other examples of conflicts needing to be resolved. Man, with technology, changes nature's balance by treating diseases caused by microorganisms. Nature does not prefer man to bacteria. Thus, the entire field of therapeutic medicine is an interference with the "balance of nature."

Politics and Medicine

In a field which on the surface would seem to be far removed from politics, medicine and its hoped-for end-result, health, are buffetted at will by the winds of political forces. War as a political force is obviously unhealthy; but some of the effects of censorship (with its limitation upon disease reporting), and of travel and transportation restrictions (causing economic and nutritional impact and in many cases, making areas inaccessible for medical care), are less obvious. Political difficulties on an international level have also undermined the effectiveness of international health organizations.

For example, in the years 1949 and 1950, the Soviet Union, the Ukraine, Byelorussia, Bulgaria, Romania, Czechoslovakia, and Poland withdrew from the World Health Organization, only to re-enter it seven years later. Taiwan withdrew in 1952, re-entering the organization five years later. At various times Portugal, Israel, Southern Rhodesia and South Africa have withdrawn from service on various committees, probably because of political reasons. A rabies epidemic is no less significant because it occurs in a nonmember nation.

Another relationship has been found in the training by institutions in developed nations of young health workers, who learn first hand either admiration for or disenchantment with political systems of the host countries. Their return home brings that nation not only a health worker, but a sometimes enthusiastic, sometimes disillusioned, and oftentimes frustrated political activist. Conflict between impatient medical and social technology and political reality is frequent.

"Free" medical care and "free" health are political catch words, completely unrealistic today and tomorrow. Modern technological advances with corrective treatment are an improvement in medical care, but they will always be more expensive than simple supportive remedies. The limits of services supported by taxation of a nation must be defined. No community can have a health service in advance of what it is prepared to pay for.

"Feasibility studies," while necessary, sometimes cost more than the budget of the program being studied. "Matching funds" from local sources are not always available to take advantage of assistance offers. These, and many other politico-economic considerations, local, national, and international, are realities to be faced.

Morality, Ethics and Medicine

Natural science is not concerned with deciding what is good or bad, only what is true or false. Nature reveals only cooperation or conflict between living things and does not evaluate the respective "merit" of those involved. In a purely scientific sense, health could be equated with biological fitness, i.e. a genetic equipment beyond reproach and a capacity for complete adjustment to the environment. But the environment is no longer static because man has acquired the power to change it and to contribute to man's evolution by the product of his mind, and man with new knowledge has acquired new authority in natural science. The biologically unfit can be given a medicated survival, the genetically suspect are permitted to multiply. Those moral issues, decided by individual health workers (and there are many) become insignificant when extrapolated to the national and international health planning level. What portion of available resources should be allocated to treatment of patients with sickle cell anemia, when assuming good care, the number of people afflicted in the next generation could be doubled? Should funds and personnel be diverted from treatment of already ill segments of the populace to disease prevention in the healthy? How much support should be given to treatment of illnesses in which the survivors will be handicapped if it means taking away from programs leading to cure? Is it wise to build a new hospital, staff it with trained personnel, and provide it with equipment and supplies when only a tiny group can use it, and the pressing needs of sanitation, transportation, education, and nutrition go unfulfilled? Do we train health workers in techniques possible in their country now, two years from now, ten, the next generation?

Lifeboat morality is a fact of life in many situations, and these difficult questions are not imaginary, a product of a philosopher's dream. They are being answered today, one way or another, as a matter of course. And what of the questions of tomorrow? Does extra-corporeal gestation have a place in rural India? Can chromosomal manipulation control the problem of sickle cell anemia in West Cameroon? Should there be taxes on, rather than benefits for children in underdeveloped nations?

Conclusion

The biological urge to survive is not confined to man, though man alone has acquired immense powers to change his internal or external environment. "The underdeveloped countries must brace themselves for a planned, coordinated, and decisive action aimed at a rapid advance in agricultural and industrial techniques, coupled with education, with rejection of wasteful and anti-social customs, with the improvement of the status of women, with the acceptance of modern methods of population control, and with the utmost austerity. The wealthier countries must realize the dangers of the present unbalanced situation and willingly accept the obligation to provide vastly increased assistance." Medicine's role in development will be played in concert with these socio-technologic changes; it cannot advance alone.

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IMPACT OF MODERN MEDICINE AND BIOLOGY ON DEVELOPING NATIONS

- COMMENTARY -

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The immeasurable benefits of modern medicine in improving the status of mankind in almost all regions of the globe cannot be denied, as Dr. Johnson has indicated so clearly. But the introduction of modern technology may also lead to unfortunate consequences, sometimes involving medical and biological phenomena.

Construction of dams for water conservation and for bringing previously arid regions under cultivation would appear to be an outstanding example of technology's attempt to cope with major aspects of malnutrition in over-populated areas of the world. Yet paradoxically, the recent (1971) completion of the world's largest dam, the High Dam at Aswan on the Upper Nile, has led to calamitous, far-reaching consequences.

The story is an intriguing one, not only from the standpoint of human medicine, but because of the disastrous chain of biological events precipitated by the opening of the dam in 1971. Planning for the project was begun in the 1950's when the late President Nasser first secured financial pledges of $268 million from the World Bank, Britain, and the U.S. to support construction of the dam. Nasser sought additional funds from Moscow, at which point John Foster Dulles, then Secretary of State, withdrew this country's support for the project. Britain and the World Bank followed suit, and Russia ultimately stepped in and contributed $554 million and 2000 technicians, swelling the work force of 25,000 Egyptians who labored 11 years (1960-71) to see the dam completed at a total cost of $800 million.

This enormous engineering achievement, a dam a mile wide at its base and equivalent in height to a building 35 stories high, was to replace the Nile's ancient cycle of flood and drought with a system of even flow of water, and at the same time provide half of Egypt's electric power. Furthermore, it was estimated that water supplied by the dam would irrigate 1,300,000 acres of unproductive land and provide perennial irrigation streams. Flooding of the Nile delta would be ended and thousands of acres of former flood plain, it was claimed, could be converted to canal irrigation and double cropping, to provide a striking increase in land productivity.

However, the biological price tag for such a technological achievement was apparently not considered by those in authority. Despite predictions by reputable scientists, including parasitologists and a distinguished Egyptian hydrologist who warned in 1960 of the hazardous consequences which would result from such a dam (and who was subsequently dismissed from his position), construction proceeded, and today, only little more than a year after completion of the project, the consequences are all too evident.

What, precisely, have been the major problems following completion of this major technological "improvement?"

1. The absence of sluices in the dam has resulted in millions of tons of rich silt being trapped, and hence made unusable as fertilizer. Such silt, formerly deposited by annual flooding of the Nile, was the source of nutriment for innumerable acres of some of the most fertile land on earth. Artificial fertilizers of comparable amount and quality would, it has been estimated, cost $100 million annually, and agronomists

now predict that millions of acres will be reduced to useless land because of the lack of silting.

2. Silt, which formerly entered the Mediterranean, provided an abundant source of food for fish and other organisms of commercial significance. The effect of this break in the food chain has decimated the planktonic forms of life and has resulted in the disappearance of sardines, mackeral, lobster and shrimp from this part of the Mediterranean. The possible effects on other forms of marine plant and animal life have yet to be assessed.
3. Because the silt, which previously added annually to the Nile delta, no longer is deposited, the Egyptian coastline is subject to increasing erosion.
4. Increased soil salinity resulting from the lack of flooding, which formerly flushed out natural salts from the soil, will probably increase to the point where millions of acres will be irretrievably lost to cultivation.
5. An explosive increase in one of man's most debilitating parasitic diseases, schistosomiasis or bilharziasis (commonly termed "blood fluke disease"), can be attributed directly to the construction of the dam and was predicted years ago by concerned parasitologists. Schistosomiasis is considered today as the most important human disease caused by animal parasites, infecting some 200 million humans. Primarily a disease of rural areas in Egypt, the causative organism (a parasitic worm, a fluke) is transmitted to man in water harboring infected snails, in which the worm passes some of the intermediate

stages in its complicated life cycle. The tiny larvae of the flukes emerge from the snail, swim about in the water, and penetrate human skin. Within the body, the parasites grow and transform to adult males and females. These copulate and females begin to lay eggs, which cause the chief damage to the body. Quantities of eggs accumulate in the human tissues, and their concentrations in such areas as the bowel and urinary pathways result in bloody stools and urine, diarrhea and enlargement of liver and spleen. Cirrhosis of the liver, abdominal pain, emaciation, and occasionally death may result. Physical and mental development of children are affected, life spans are shortened, and the working capacity of adults is reduced to an enormous degree. With insufficient labor, development of agriculture and industry is curtailed, and progress of the nation is retarded due to the debilitating nature of the disease. The average life span of Egyptians in rural areas where the disease is rampant is 25 years for men, 27 years for women. The two species of schistosomes or blood flukes occurring in Egypt have been known to be present in that country since the time of the pharaohs. Before construction of the dam, an estimated 14 million cases existed in a total population of 40 million inhabitants. The number of cases today is not precisely known, but in some areas the rate of infection in man has increased 80%. Because perennial irrigation of thousands of acres now increases the potential habitat for snails in newly constructed irrigation ditches, and because of the enormous reproductive capacity of snails (capable of multiplying 50,000 fold in only 4 months), the spread of the disease is virtually assured, despite continuing attempts to control it.

6. Ecological problems, too, are besetting Lake Nasser, the 350-mile-long impoundment behind the dam. Seventy-five percent of the fishermen on that lake are now infected with schistosomes. Lake Nasser is not yet filled, despite estimates that it would be in 1970, and according to some authorities it may not be filled for two centuries. The huge surface area of the lake and the attendant loss of water through surface evaporation is resulting in a greatly diminished water supply. Seepage and underground flow away from the dam area are additional factors contributing to the loss of water. It is ironical that much less water is at hand than had been envisioned by promoters of the project. The problems evidenced as a result of the Aswan Dam reemphasize the need for caution and the necessity for careful evaluation of the multiple potential problems inherent in the extension of agriculture into formerly arid lands by irrigation, particularly in areas where schistosomiasis is rampant. No better example than the Aswan Dam can be cited for the need for closer collaboration between scientists and technologists of diverse disciplines to avoid the tragic failure of a project designed for the betterment of mankind.

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AGRICULTURAL TECHNOLOGY: VANGUARD OF ECONOMIC DEVELOPMENT

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AGRICULTURAL TECHNOLOGY: VANGUARD OF ECONOMIC DEVELOPMENT

-ANIMAL PRODUCTION-

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Dr. T. C. Byerly, a graduate of Iowa State University and later administrator of Cooperative State Research Service, USDA, said, "It is an obvious fact that young people of today are taller than people of my generation." He drew a causal relationship between the increased height and a 10 gram increase in the daily per capita protein consumption between 1925 and the 1950's. The 1964 World Food Budget stated, "There is no simple unit for measuring the nutritional quality of the diet. However, protein content, particularly the animal protein content, is a widely accepted indicator of nutritional quality; a minimum allowance of 60 grams of protein per day of which 10 grams should be animal protein."

Byerly conceded that there is no known food essential in animal products which cannot now be provided from vegetable sources or by synthesis. However, he said, "I wish here, only to remind you, that almost everybody has food preferences. Preference for a rare steak or a prime rib cut over hamburger reflects more status difference than nutritive value. Most of us don't eat horse meat, though I guess we would choose it over crow. Most of us reject blood and guts. Why?" Down through history man has struggled to get meat. Man likes meat and, within broad limits of appetite, he will pay more to get what meat he wants than for plant food products.

According to Paarlburg, the world food picture is far better than one might think from reading the headlines. Consider these facts:

1. The average person in the less developed countries, though still poorly nourished, now eats better than his father did.
2. There has been no major famine in the world during these post war years. There is no known previous period of equal length of which this could truthfully be said.
3. Prices of agricultural products have been declining in world markets, having fallen about nine percent since November of 1963. This is hardly an indication of a serious general deterioration in world food supplies.
4. Per-capita real incomes have risen in almost all of the countries of the world. A part of this increased income has been spent, as one would expect, for increased quantities of food. Concern regarding food in many parts of the world is, in part, a reflection of the greater purchasing power and, hence, the greater effective demand which results from economic development.

Catron and McRoberts contended that animal proteins may become more of a dietary luxury in the future because:

1. The population will almost certainly double by the end of the century;
2. There is direct competition between animal and man for plant protein;
3. Animals are inefficient nitrogen and plant protein converters;
4. Animal production requires another step involving additional inputs, risks, and time; and
5. Income levels may not permit the purchase of animal proteins in many regions of the world.

There are a number of factors operating toward increasing the production of animal proteins. Most people like meat, milk and eggs. People usually eat what they like or are accustomed to, if they can afford it. In highly industrialized countries, where wages are good, more people are eating out, and most restaurants feature meat as the major entree. Broiler production, the epitome of efficient meat production, is a highly developed technology that can be, and is, packaged, transported and operated in many parts of the world. Most of the "bugs" are out of the business; the investment is moderate; the turnover fast; and most people like chicken.

Cattle, sheep, and goats using untillable grazing lands and crop waste materials, can make even greater contributions to the world's meat supply with efficiency improved by research. In some underdeveloped countries, milk cows and laying hens are prestige symbols, with the advantage of being able to produce animal proteins (milk and eggs) without sacrificing the animals. Babies need milk. With the present world birth rate, there is a strong need for milk. Milk cows not only can use pasture, roughage, and urea (noncompetitive with humans), but they are also the most efficient converters of feed grade nitrogen to animal protein.

According to Byerly, the world population of livestock includes about one billion cattle, one billion sheep, 550 million pigs, 350 million goats, 100 million buffalo, 64 million horses, 40 million asses, 15 million mules, and 11 million camels. It would be interesting to know the dog population. Some people say they make good tacos and tamales.

Technologically, we have reached a very high level of animal production in the United States. In beef cattle, we can easily achieve

90 percent calf crops, calves that will gain 90 pounds per month with about a 5:1 efficiency, and produce a very acceptable product. In hogs, we can produce a similarly suitable product, with sows producing eight pigs per litter, each with the ability to weigh 225 pounds in 150 days or so, with a 3:1 feed conversion ratio or less. Dairy herds of close to 100 cows in Iowa have exceeded a 17,000-pound average milk production. We commonly produce broilers with 2.4 pounds of feed per pound of live broiler sold. We are constantly amazed by the improvement brought about by application of technology.

In contrast, however, I have worked in development programs abroad where cows achieve 35 percent calf crops, and the offspring attain market weight at five years. I estimated that each animal gained 600 kilos to eventually market 360 kg (the difference being due to winter weight losses). Getting these to market in three years would double the carrying capacity. As it is, they scarcely replace themselves. I don't feel that it would take much management effort to change these low levels of production, but it is questionable that they will be changed without outside intervention.

Animal agriculture in the emerging countries (and characteristically of Asia) has been described by Phillips as follows:

1. Animal agriculture is practiced in many diverse forms, so a major characteristic is its variability;
2. On the whole, the emerging countries are well stocked in terms of animal numbers;
3. Animals produce much of the draft power that is essential to plant agriculture;

4. On the other hand, the contributions of livestock and poultry to animal protein supplies are very low, either in comparison with levels of production in developed countries, or in relation to the needs of people in the emerging countries;
5. In many countries, animal and plant agriculture are not well integrated;
6. Neither the art of animal production nor animal science is well developed in most of the emerging countries;
7. The development of animal production is further handicapped in most emerging nations by the lack of adequate processing and marketing facilities;
8. Religious beliefs and social customs that inhibit the efficient production of animals, and the use of animal products are further deterrents to the development of the animal industries in many emerging countries, and low economic levels are a deterrent in most of them;
9. Population density is already a serious deterrent to increased animal production in many emerging countries, and rapid upswings in population numbers are further enhancing the difficulties; hence, there is strong competition from food crops for the use of arable land, a competition that seems certain to grow stronger as the population upsurge continues; and
10. Leaders in animal science are few, and institutions are not yet available in the emerging countries to train an adequate corps of such workers.

According to Konnerup, some of the problems of African animal production may be improved within the near future. However, to maintain the overall production requirements to barely keep pace with population growth during the last third of this century will take a sustained, vigorous effort, not only on the part of the African nations, but by external agencies and foundations as well.

The basic requirement is advancement in the technology of animal production. This advancement depends on a massive effort to extend training and education in the fields of management and animal health. Efficiency of livestock production, according to Byerly, is often low. Brazil, for example, apparently has increased its national cattle herd from about 50 million head to almost 80 million during the past 15 years. Yield per inventory head has apparently decreased. It was only about 45 lb in 1950, compared to about 90 lb in neighboring Argentina. The recent reported rate is only about 35 lb.

The seeming great wealth of livestock in numbers in the less-developed countries turns out to be a great poverty. In fact, the paradox is that a much smaller number of well-kept animals would not only produce more meat and milk, but they would need less land for pasture and forage crops, thus releasing land for growing food for the ever-increasing number of man.

A major factor limiting efficiency of cattle in tropical countries is low net reproductive rate, a puzzling contrast with the high net human population increase in many of these countries. There are almost as many cattle in the United States as there are in the vast African continent. Europe has a few more. It is not land that is limiting beef production. Europe, not including the U.S.S.R., contains about 1.1 billion acres; the United States has about twice that; Africa has 5.5 billion.

Concerning Latin America, Cox relates the following:

1. Latin America and the U.S. have about the same number of people: 200 million;
2. Latin America has twice as much land and twice as many cattle as the U.S.;
3. Latin America has one beef animal per capita, and the U.S. has 0.5 beef animal per capita;
4. Latin America produces about five million tons of beef per year, and the U.S. produces about 10 million tons;
5. With twice as many cattle, Latin America produces half as much beef as the U.S., making the ratio of productivity 1:4;
6. Latin America, then, is feeding four times as many cattle as the U.S. to produce a ton of beef; and
7. Slaughtering rates vary from 10 percent in Brazil, to 22 percent in Argentina, to 35 percent in the U.S.

According to Catron et al., education levels must be raised in the developing countries before they can effectively understand and use the needed minimum food production technology. Hungry people cannot eat our "know-how," but technology is the easiest and most economical production input to export to developing nations to help their people help themselves.

Animal production technology should follow plant production technology into these countries, because a successful animal agriculture depends upon a successful, abundant crop production. It also requires a mastering of additional, more complex capabilities. As was indicated earlier, animals can use surplus feeds and can graze on the grasslands and crop residues, and thus produce, though inefficiently in one sense, the meat products which we desire.

Permanent grazing lands constitute about 64 percent of the world's total agricultural land. Areawise they vary from 34 percent in Western Europe to 95 percent in Oceania. Most of these lands are too rough, too dry or too poor for crop production. Some are forest range lands which can be used only by cattle, sheep, and goats for animal protein production. Animals grazing these lands also produce leather, wool, some milk and cheese, and other animal byproducts. In these areas of the world, draft animals and beasts of burden can also use such grazing lands.

In the past, livestock and poultry have played a great role as scavengers in converting and upgrading a multitude of waste products into meat, milk and eggs. However, in industrialized countries, technological developments and increasing labor costs will probably decrease this role as scavengers in the future. However, many humanly inedible byproducts of various industries continue to find their way into the feed industry, eventually ending up as animal proteins. Wherever there is a known demand for animal proteins, with sufficient consumer purchasing power, ingenious agribusiness men will invest capital and technology, if they can foresee a reasonable return on their investment without undue risk.

We have not however stood idly by, ignoring the plight of the world that surrounds us. We in America have sought to extend ourselves to help others to help themselves, and our efforts have borne fruit. Sometimes it is very visible and other times very hard to see. Many of the effects have caused endless frustrations. Nevertheless, a great deal of emphasis and dollars went into "foreign development" in the 1960's. The Point 4, ICA and USAID spent many many dollars on many useful projects and educated many people from abroad. FAO has had, and is having its impact. Foundations like Rockefeller and Ford, among others, have done a great deal. For example, from 1959 to 1971, inclusive, the Ford Foundations spent approximately $175,000,000 in Latin America and the Caribbean. Thirty-eight percent of that money went for education and research. Just since 1968 Ford has sponsored 113 fellowships, mostly toward PhD's. The Rockefeller Foundation has financed 278 MS students and 208 PhD programs from Latin America since 1960.

Our university contracts have had varying degrees of success in training and/or development. I feel we are at a crossroads. We have trained technologists but we didn't wait for them. Whereas developmental change has occurred in the emerging countries, ours hasn't stood still, so it may be that the gap is widening. The institutional strangleholds often squelch a good young man's enthusiasm, so we can still play an important technological role abroad.

I feel quite fortunate, having worked in five other countries and traveled in ten as an ISU staff member. According to our guestbook, we have had visitors in our home from 18 countries (all the relevant continents) in the past five or six years. My knowledge of the languages of Latin America has made it easy for me to maintain a grass-roots feel of the local situations. I think I have an intuitive feel for a needed change in directions. We have spent much time, money and frustration abroad in:

1. Situation analyses;
2. Historical reviews (economic analyses);
3. Training potential leaders;
4. Maintaining an administrative bureaucracy within many countries;
5. Perhaps overtraining some people; and
6. Not laying the base for those we train to be able to return home to accomplish.

The needs in agriculture, and specifically in animal agriculture, are so acute in most countries that even the affluent ones are in trouble today. The price on beef in Europe is twice that of ours. There is beef rationing in Argentina, Chile, Peru, Uruguay and Columbia, Japan is emerging as a beef "wanter." Russia is trying to expand to meet its beef needs. Yet in producing the technical people we have made lots of mistakes including:

1. Overtraining — We are all for sound and in-depth graduate programs, but we seldom teach our foreign charge to muddy his feet or soil his hands. Many of those we trained return home hoping to relive their PhD thesis experience over and over when there is work to be done and often only fingernails to do it with.
2. Failing to implement meaningful action programs — Too often "advisory" groups go to a country to size up the place. They often are at the mercy of a sharp bureaucrat interpreter. They wine and dine, write and report, and that's the end of it; words and no solutions!

3. Giving the right answer to the wrong problem — When I was in Paraguay in 1967 the Peace Corps kids were pushing rabbit projects. Paraguay had rabbits sticking out of every palm tree. Yet, the Paraguayos didn't want rabbits because there was no market. One Peace Corps volunteer said, "I'm a horticulture graduate, I wanted to help where I can do the most good. They need me in horticulture, but my assignment is 'spread the rabbit gospel.'"
4. Spending too much time getting oriented and too little at the task at hand — I've seen many Americans live (and work?) abroad a year and a half before getting proficient enough at the language to communicate with counterparts; then four months later it's time to start packing because the two-year stint is over.
5. Spending too much time on an "ego trip" and not enough developing nations — A foreign assignment is a good place to build an image if you can show some dramatic results and can circulate the news back home. But what about the job at hand? Who will do it when you are gone?

The need is apparent to enter a new phase. Let's call it the Legitimization Phase. In too many places, those we've trained have gone home to face disappointment. Institutional or political instability, bureaucracy, and budgetary insufficiency have left many of our trained technologists out in the cold. Many have only part-time professional employment, having to make their living outside and thus having to partition their interests. Most of those I know prefer to work "full-time." "Full-time" is a term one hears referred to often in Latin America.

I submit that lack of desire to work and accomplish is not a stumbling block. Given the challenge, the direction, the wherewithall, and the incentive, every counterpart or group of counterparts I've had was willing to DO. Oftentimes their "overtraining" or "position in life" stood in their way. In our zealousness to train we have sometimes forgotten to build enthusiasm for plain old work. Also, we too often teach only the answers and not often enough how to ask questions, how to challenge the status quo. In bringing about solutions, one needs to know how to identify the problems and establish priorities in achieving their solution.

An important aspect of legitimization needs to be done at the level of the politicians, the administrators, the industrialists, and the pace-making agriculturalists. I, as an emissary of Iowa State University, the United States, or the U.S. State Department, seldom have difficulty getting "in with the big shots" in Latin America. I am an authority! My credentials say I am! My language facility adds novelty to my prestige! I can be one of the boys! I can understand their problem! But too often, my local counterpart who may be a Cornell, ISU, or Colorado State PhD has a different problem. He is one of the kids "we sent away to school." He has no political influence; his name is nothing; he is too pushy, too ambitious; the words he uses are too big, so give him some little task to recognize that we sent him away to be trained, but get him out of the way quickly; isolate him!

Within the word isolation is another world of sadness. How many well-trained young men and women do I know who could benefit from interaction with other professionals of similar training in neighboring countries, or who could use the consulting expertise of another neighboring expert from time to time. Through the use of the right people and the right approach we could do a big job in legitimizing our "trainees" back home, so that they could do those things they were trained for. I see isolation as one of the sad realities of no follow-up.

I was among the lucky ones; my missions were at the right time. The things my wife and I have done in the Argentine were needed THEN. The study that she and the locals did on family living situations was highly touted and recognized, but the MEN administrators really never did anything about it. In contrast, my work in swine production bore fruit. We took the hog out of the mud in the Argentine. We taught them to save pigs, to feed protein, to recognize a superior carcass, and to build testing stations. Ten years later, the programs are successful. The same is the case in the beef cattle programs that we initiated. "Our boys" have done much to improve their research plant and to restructure their teaching methods to oriented-learning rather than the unstructured do-your-own-thing system which was.

The problem identification job that I did in Paraguay, and the legitimization that I tried to do within the country, led to substantial expansion of the USAID-New Mexico State-Paraguay program. I am told that this program is considered one of the accomplishment models. They've trained men to solve problems and have provided a means for them to do so on their return. There's so much to be done. The problems of animal production worldwide, and in relation to our university commitment to help solve them, do not stem from technological insufficiency. The solutions are more dependent on institutional and political adjustments and proper use of trained people in implementing proven methods.

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AGRICULTURAL TECHNOLOGY: THE VANGUARD OF ECONOMIC DEVELOPMENT

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> "We can, if necessary, do without many of the conveniences we take for granted: washing machines, television sets, automobiles...all products of our major industrial enterprises. What we cannot do without is food with a high enough protein and caloric content to sustain human life. Except to the extent that the industrial establishment contributes to the production of food (through tools, inorganic fertilizers, pesticides, distribution and storage systems), industry is at best peripheral to the needs of humans and at worst superfluous. This may seem so obvious as not to be worthy of mention, yet when the 'planners' establish national or international priorities, they frequently appear to forget that farms and farmers can survive without the cities, but that the cities and their attendant industrial belts cannot survive without the farm."
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> Food: An Energy Exchange System/Kaiser News. 1970.

Need for Economic Development

Many thoughtful people have recognized the collision course of a soaring world population and a static food supply. One of the latest, Lord C. P. Snow, said in 1968, "At best, this will mean local famines to begin with. At worst, the local famines will spread into a sea of hunger. The usual date predicted for the beginning of the local famines is 1975-1980. Many millions of people in the poor countries are going to starve to death before our eyes."

Preventing this prediction from occurring has been accepted as a challenge by intellectual people throughout the world. They believe that rapid economic development will solve the food problem, raise the standard of living of a country and contribute to nation building.

The governments and private foundations of developed countries have implemented massive foreign aid programs and the governments of the brink-of-disaster nations have written five-year economic development plans. They have done this because they know that the rise and fall of civilizations has closely paralleled the success of farmers in producing food. They also know that a nation turns to civilization building only after the farmers have been able to provide an adequate supply of food. The food supply problem was solved in each developed country by developing the art of carrying out the necessary tillage and cultural practices with a unique set of tools and equipment. Ancient civilizations flourished as a result of the invention of irrigation and the ard (scratch plow) and in Europe as a result of the invention of the moldboard plow. In each case, the people needed for civilization building were released from food production only after the tillage operations, and to a lesser extent the threshing and grinding operations, were powered by slaves, animals, or in later years, by tractors.

Each plan of the developing countries has directed the nation's resources into either the industrial sector or into the agricultural sector. The next five-year plan of the nation invariably shifted the national effort from the sector presently being emphasized to the other sector, and each plan in turn failed to reach its stated goals because the sector not being supported failed to sustain the planned economic growth.

For economic development to succeed, the industrial sector and the agricultural sector must move forward together. This is accomplished when the industrial sector deals with the manufacture and supply of agricultural machinery, supplies, and services, and when the agricultural sector is geared to use these machines, supplies, and services.

This happens when agricultural technologists provide the catalytic function in both the agricultural sector and the industrial sector. The major objective of this paper is to discuss the role of the agricultural technologist in supplying the services needed to ensure the successful growth of each sector and to produce an adequate supply of nutritious food.

The Role of Agricultural Technologists

Working in agriculture, the agricultural technologist is needed to do the following:

1. Invent, design, develop, and manufacture or select and test tools and equipment needed by the farmer for tilling the soil, planting the crop, harvesting the crop, processing the crop, and transporting the product;
2. Design and construct buildings to house the livestock and store the crop;
3. Design and build structures for the control and use of water and for conserving the soil;
4. Select and breed adapted varieties of economic crops;
5. Provide retail suppliers and marketing services for the economic crops; and
6. Conduct research on tillage systems, crop drying, crop storage and processing, irrigation, drainage methods of conserving water and soil, crop introduction, and crop breeding. The agricultural technologist must not only understand the crops and soils of the area and the job to be done, but he must understand the people and their economic and political environment.

After the designs are established, the agricultural technologists must work with local industry to transfer the new ideas from research concepts into commercially produced machines, buildings, supplies, or services. The new device must be designed for production under local conditions, jigs and fixtures designed and built, manufacturing operations detailed, and assembly lines established for manufacturing the machine. The manufactured product is then tested for function and for service life under local conditions.

Lastly, the agricultural technologist is needed in agriculture to help the farmer understand the use of the new design and help him use the new machine, building, or system profitably on his own farm. In order to further improve the efficiency and economic position of the local farmer in the world market, the new device, supply or service must be further developed by the technologist and the selling price reduced.

You may ask the question, if agricultural technologists are so important, why didn't the professions develop earlier and why are their numbers so few? The answer is simple; the professions developed and grew for the most part outside the academic community in both the United States and Europe.

A review of history shows that the founding fathers of the agricultural machinery industry were blacksmiths. Blacksmithing was an extensive occupation in the U.S. because horses were used for farm work, as well as for transportation on the 19th century farm. The blacksmith shod the horses, built and repaired wagons, and manufactured tools. As the need for agricultural machines became evident, it was natural for him to invent and begin the manufacturing of farm machinery.

The various agricultural technologist professions developed after the turn of the century in the United States, when men with technical training were needed to design the increasingly complicated machines and tractors, to breed plants and animals, and to classify and make recommendations for fertilizers and other chemicals. Some of these professions did not materially develop in Europe until after World War II. The need for agricultural technology in developing countries goes far beyond that of providing technical services.

National leaders are needed to formulate and carry out agricultural policy. They must be able to look beyond the improvement of a tool to the development of a completely new crop production system; beyond the design of machines to replace manual labor to the design of new machines that do entirely new jobs now impossible to perform by hand. The specific design of an irrigation ditch turns into planning for the use of the land and water resources. Manufacture of import substitution goods changes to the manufacture of capital generating equipment for the basic industries of agriculture, mining, forestry and fishing.

It may be argued by some that the generalist, the person educated in the arts, is more capable of making these decisions; that the technician cannot see the forest for the trees. This is simply not true. The agricultural technologists have been dealing with the development of agriculture all along. The moment they are allowed to create policy in national development, they will take to it like a duck takes to water. But the problem is that the technologist like anyone else, needs many years of experience in various management tasks before he is thrust into making national policy.

Because the people making up the technology professions of developing countries are relatively young, many will be forced into policy positions long before they have developed a mature view of their professional responsibility in national development. This is one area where experienced foreign agricultural technologists, with a long history in agricultural development, can render invaluable advisory service.

Necessary Conditions for Economic Development

We have said that for economic development of a country to take place, there must be simultaneous industrial and agricultural development. Industrial development must be primarily concerned with the production and marketing of agricultural tools, equipment, supplies, and services. Agricultural development must be concerned with the use of these tools, equipment, supplies, and services in ever increasing numbers for production, processing, storage, and transportation of farm products.

When the agricultural revolution coexists with the industrial revolution, a large number of economic forces come into play by the double revolution. The agricultural technology industry siphons[1] off to the city the rural labor supply to build farm supplies and agricultural services. The farmers are then forced to substitute capital investment in machinery for labor or pay higher wages. The money the manufacturer receives for his machinery and supplies is used to hire more labor away from the farm and the farm wages rise again to compete with the price of industrial labor. As the prices rise, the money earned by the labor above that needed for the purchase of food is spent for new goods and services. This creates a sound basis for the development of a consumer goods industry.

As the farmers increase their use of technology, the cost of production decreases and the number of acres that can be farmed increases. This two-fold effect increases the productivity of the mechanized farmer, and a plentiful supply of inexpensive food becomes available for purchase by the urban population. Using the profits of farming the mechanized farmer purchases or rents additional land from the farmer who did not mechanize or use agricultural supplies or sources.

This review shows that economic development was propelled by the agricultural technology industry, that agricultural revolution coexisted with the industrial revolution, and that they fed on each other. While this was the model for the 19th century development of America, it is far different from the conventional 20th century foreign aid approach. To get agricultural development moving, the foreign aid officers of a developing country invariably start an activity that has nearly a 100% possibility of success. Using imported fertilizer and insecticides, they demonstrate that yield per acre can be increased.

When it is found that these inputs do return a profit to the farmer, there is an immediate temptation to recommend that the national planner build chemical factories and start producing these inputs to save foreign exchange. This may sound logical, but nothing could be more disastrous at the beginning stages of development. Managers, engineers, and money, already in short supply, are tied up in manufacturing something that could be imported.

There is nothing unique about fertilizer or pesticides that requires it to be under continuous development in a specific country. Once the proportion of nutrients is established in a particular country, the dials can be set and the fertilizer can be produced any place in the world where the ingredients are available. The available management, engineering and money in the country should be used to establish a farm machinery industry to produce equipment adapted for the local crops and conditions. These chemicals and other supplies are imported as needed to supply the agriculture industry. It goes without saying that if the raw materials are available, a chemical industry should be established.

Though the above prescription for economic development appears simple and straightforward, it has been missed in nearly every economic development plan put forward by national planning commissions or by foreign aid programs.

Conditions for Development

A nation develops when the following conditions are met:

1. The percentage of the population employed on farms is decreasing;
2. The number of persons supplied with food and fiber per farm worker is increasing;
3. The energy used by each individual worker in industry and on the farm is increasing; and
4. The percentage of the worker's income spent on food in decreasing.

There is a direct relationship between the percentage of the population engaged in agriculture and the percentage of the worker's wages spent on food. The industrial laborer of developing countries spends a very high proportion of a very low wage on food. There is little left in the pay check to buy other goods and services. Therefore, there is little motivation for the development of a consumer goods industry. Agricultural workers, using the products designed by agricultural technologists have a higher work index and direct and use more energy than workers in any other industry. The standard of living in a country closely follows the work index of the agricultural and the industrial workers.

The above four conditions are easily met when the following developments are happening simultaneously:

1. The farms are using more efficient tools and changing the form of power from human to animal to tractor. Instead of doing the job by hand, animal or tractor powered machines are used to till the soil and thresh the grain. The planting, weed control and harvesting are done with improved hand tools or animal or tractor drawn equipment.
2. The farmers are using off-the-farm inputs such as fertilizer, pesticides, and machinery to augment the fertility of the soil, provide pest control and improve the environment of the plants.
3. The agricultural machinery industry is providing repair services for the machinery and other commercial or government organizations have been established to provide advice and supply the off-the-farm inputs.
4. A system of long term and short term credit is available to the farmers.

5. Transporting and marketing systems are moving and selling the farm products.

While it is conceivable that the four conditions mentioned above could be met, and the five simultaneous happenings could take place without professional help, the facts are, that they have only taken place in developing countries when agricultural technologists played the catalytic role. This is the same role he played and continues to play in the developed countries. He is not thought to be a part of the agriculture and manufacturing industry. The reason is that a good catalyst accelerates the process without becoming a part of the final product.

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CROP PRODUCTION

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Civilized man has been wholly dependent upon cultivation of plants. Without cultivation, he was nomadic and could not settle long enough to develop a higher culture than that of the hunter or the herdsman. Just under the masthead of a farm magazine we used to receive was the quotation, "Civilization begins with the plow." The author, if credited, is now unknown to me but the statement came back, after perhaps three decades, as thought was given to this topic.

Daniel Webster said, "When tillage begins, other arts follow." Have you seen it on the campus? It is evident, then, that the title of this set of three reports is not new or original. The idea has been around for years; only the words have changed. Agriculture concerns itself with the production of food and fiber; ultimately with feeding and clothing man. These reports have arbitrarily divided the topic of agricultural technology into the technology of animal production, the engineering technology of producing, harvesting, storing, managing and transporting of animal and plant products, and the technology of crop production.

Food has always been of critical concern to mankind for obvious reasons. Mankind has lost significant numbers of its members due to lack of food and the quality of food, and countless millions more have suffered from undernourishment and malnourishment which have deprived them of fullest satisfaction from the life they could lead. The Old Testament records famine in Ancient Egypt and the surrounding regions.

Famine has occurred in more recent times and even today a significant part of the population of the world is undernourished or malnourished by standards which we have accepted as being adequate. An increasing population continues to put pressure on the world's food producing capacity.

Major breakthroughs in crop production have been made in the temperate zones of the earth. Perhaps the most significant have been in North America, where history, culture, opportunity, desire, and natural resources coincided in a way which had never happened before and, to the best of our expectation, cannot happen again. The price we have had to pay for this success is really unknown, but certainly is being extracted in cultural values, personal values, national fiber, the environment, and dissipated natural resources. These costs may not be pleasant to admit. It is no wonder that everyone is not rushing to follow in our footsteps, which are clear enough to see, as are some of the consequences. Yet, some of the alternative routes to economic development which are being followed seem to us to be ineffective and certainly would not be acceptable to us.

No one in this seminar has yet asked why we are concerned with exporting technology to other countries and cultures. I am asking because I believe the question should be asked, but I do not plan to fully answer this question. Suffice it to say that without our export of technology, there would be less, perhaps no serious confrontation of technology with foreign cultures; at least we probably would not be concerned with it.

More to the point for this seminar, however, is the question: Why are we exporting agricultural technology? Why are universities interested in USAID contracts abroad? Is it because they, like the mountain, are simply there to be conquered? Are our faculties too large and underemployed at home and are we trying to justify our existence? Are these assignments simply nice excursions abroad which faculty members can take without making a serious commitment? What are the real answers?

It appears that our most recent interest in exporting agricultural technology had its origin in the declaration of the United Nations Conference on Food and Agriculture which met at Hot Springs, Virginia, in June 1943[1]. This, apparently, was the first time the term "United Nations" was ever used for an official activity, and one of the freedoms declared for mankind was "Freedom from Hunger." The interim commission arising from this conference drafted the constitution for the Food and Agricultural Organization (FAO), which became an agency of the United Nations after the latter was established in 1945. It is of interest to note that FAO preceded by a few years the World Health Organization (WHO) of the United Nations.

Relative to food and agriculture, the Hot Springs Conference adopted a set of policy statements for its member governments. These provided for adjusting agriculture to increase and balance production of food with consumption throughout the world, and for collaboration among nations, locally and internationally, to achieve this increase and balance, as well as for commodity arrangements, marketing services, and special efforts to achieve wider food distribution[2]. All of these policies were reaffirmed by FAO itself in Quebec in October 1945.

The conference in 1943 declared, "There has never been enough food for the health of all people. This is justified neither by ignorance nor by the harshness of nature. Production of food must be greatly expanded; we now have knowledge of ... the means by which this can be done. It requires imagination and firm will on the part of each government and people to make use of that knowledge."[2] A similar conclusion that the goal of enough food for all is attainable during this century was reached by members of the Pontifical Academy of Sciences Study Week on "Use of Fertilizers and Its Effect in Increasing Yield with Particular Attention to Quality and Economy" in April 1972. Incidentally, I too have given this optimistic message to two seminar '70 classes on Natural Resources.

The United States is a member of the UN and FAO and has participated in the activities of these two groups. In addition, the U.S. has instituted its own food programs as well. Admittedly, many of these have seemed to be for purely selfish reasons; nevertheless, others have had a greater desirable impact upon the recipients than on the U.S. We are exporting agricultural technology because a world body has recognized this need and has asked for this. We can comfort and justify ourselves by saying we were called and point to the humanitarianism of helping to feed the hungry.

While food may be produced in centers of productive soils, climate and advanced technology, with few exceptions, it needs to be produced near the point of use. Hence, each country needs to be self-sufficient in food production. The exceptions are highly industrialized countries or countries with abundant resources to export, e.g., Japan and The Netherlands in the first case, and perhaps Saudi Arabia in the latter. Living on an exhaustable resource, however, is a short-term alternative. Any foreign exchange saved by not importing food is available for use on items which cannot be produced or are not available in the country.

These may include items needed to produce the food. This brings to mind a saying frequently seen in FAO publications: "Give a man a fish and you feed him for a day; teach him to fish and you have fed him for life," or words to that effect.

It is not enough for a country to produce its own food. If it is interested in improving its standard of living or enriching its culture, a certain degree of efficiency of food production must be achieved. A population in which over 90 percent of the effort of its members is devoted to producing or preparing food, does not have much time available for cultural enrichment nor labor for economic development or anything else. Presently, those countries with high standards of living and strong economic development are those with less than 50 percent of the population devoted to food production. Whether these also have superior cultures is really doubtful or at least beside the point; however, in these countries the people certainly have the resources and time to devote to cultural pursuits, rather than to survival. Efficient food production need not interfere with or run contrary to most cultural values; however, it will cause a different social structure or behavior or both. It does not seem possible to gain the benefits from efficient food production without major social adjustment. This has happened in economically viable Western countries and is happening in countries now experiencing economic development.

Most cases of starvation and malnutrition occur in the tropical areas, with the exception that some densely populated regions of eastern Asia also are frequently short of adequate food in quantity and quality. This presents some serious problems in the export of crop production technology, even though there seem to be few cultural taboos relative to plant-derived foods, as long as we do not consider some stimulants, usually beverages. There are, however, strong preferences for certain foods, e.g., sorghum preferred to wheat, maize to wheat, rice to sorghum, etc., or even, as has been pointed out in earlier seminars, a preference for a particular type of rice.

Ignoring the mechanics of production (which have been considered by Dr. Buchele), the agricultural technology of crop production usually involved changing the crop by selection or breeding, changing the soil by management and fertilization, or changing the climate-related environment; e.g., irrigation, drainage, tillage, etc., or any combination of these. Because soils are strongly influenced by climate and many crop plants are day-length sensitive, it is quite easy to move production technology, including crops and their varieties east and west within the temperate zones where we really do not have much of a food problem. This temperate zone is where the oldest and the most research stations and universities are found. But the tropics present different soils, and different light and dark periods, and may also require a change in crops instead of varieties, especially at low elevations.

Because we cannot displace plants with impunity either north or south from the temperate to the tropical zone, it is not surprising that some of the most publicized breakthroughs have come from the Centro Internacional Mejoriamento Maiz y Trigo (CIMMYT) and the International Rice Research Institute (IRRI), both of which are south of the Tropic of Cancer. Nevertheless, these advances were based upon principles and plant characters established and found in the temperate zones and synthesized into new superior varieties of wheat and rice by plant breeding principles, based upon classical Mendelian genetics.

It is possible to make rapid progress in improving crops in the tropical zone which are also grown in the temperate zone, e.g., maize, wheat, sorghum, etc. This is because many basic characteristics of these crops are known and the breeding and selection may be pursued immediately. It is not necessary to first conduct exploratory experiments to establish the nature of pollination, inheritance, characters, etc. Hence, this task is well within the capability of a trained plant breeder who has access to the literature on these crops. On the other hand, much less is known about crops which are unique to the tropics, e.g., plantain, cassava, perhaps sugar cane, etc., and a program of improvement of these is destined to be slower. Yet they still require some of the relatively simple botanical, genetic, statistical, and plant breeding procedures and tools which are well known. The facilities needed are very modest, but time is essential. Plant breeding is based upon crossbreeding of plants, each with some desirable characters, reproducing the progeny with or without additional crossing, and selecting for desirable recombinations of traits and improved yields or quality. Hence, a certain number of generations is required and these cannot be hurried, although more than one generation per year of some is possible. Generations of other crops take longer than a year, e.g., plantain, sugar cane.

Given time and the incentive, plant breeders probably can increase the biological efficiency of any food producing crop grown and still retain in the produce the essence of its appeal to the taste, smell, and sight of those consuming it. IR-8 rice varieties were developed for production in the Phillipines and Southeast Asia. They can even make IR-8 derived rice varieties taste and handle like the native rices of southeastern Asia. In cases such as this, one has to decide which is of higher priority, the quantity or the relative quality for consumption. The option in the case of IR-8 was for quantity. A new set of priorities for plant-type selection in the future may include resistance to diseases and insects, eating quality, protein level, amino acid balance, etc. The more crop characteristics that are specified, the longer it will take the plant breeder to develop the ideal.

Another consideration is the time which we have available to improve crops. Accepting the fact that certain cultures may prefer cassava or plantain as a source of energy in food rather than cereal grain, or may prefer olive oil to other vegetable oil, there may not be the time to increase the production of traditional foods to meet the needs, and changes in food habits must be made. This is not impossible. For example, soybean oil has been accepted widely as a substitute for olive oil in many uses and even as a substitute for dairy fat in margarine.

The study of plant growth and yield as related to use of fertilizers and other management factors has fallen to soil scientists. Soils are, in part, a result of the climate, but are also affected by topography, parent material, vegetation, and time. Not all soils are alike but a universal soil classification system has been developed. It is possible, therefore, to make an inventory of the soil resources and thus gain significant knowledge about the inherent productivity of soils in any country, management problems associated with the soils, potential productivity, and the inputs needed to realize the potential. There are a number of levels of detail for soil classification and mapping possible, but the ultimate detail is not needed in the first steps of adopting agricultural technology. However, some understanding and delineation of the soil resources is necessary to consider alternative practices from the general technology available.

The most frequently used soil amendment to increase crop yields in semi-arid, sub-humid, and humid regions is the application of fertilizers. These may be organic or inorganic in origin and may be derived from urban and agricultural wastes, from mined deposits or manufactured from deposits or from constituents of the atmosphere, i.e., nitrogenous fertilizers. All are equally acceptable for most purposes and plants cannot distinguish among them as a source of soil-derived essential nutrients, because all are absorbed from soil in ionic form. With the exception of anhydrous ammonia, all may be applied with simple implements or by hand.

At this point, it should be pointed out that some cultures, perhaps most, assign a very low social status to food producers or those who work with the soil. This is as true of the peasant in Europe and country hicks in the U.S. as it is in India. The main difference, it seems, being that the peasant and hick can at least aspire to something "better." As long as these attitudes persist in the various cultures, there may be relatively slow improvement in production efficiency. Also, nationalistic considerations seem frequently to make a national airline, a steel mill or the modernization of an army more important and of higher priority than adequately feeding people, and probably more expensive as well.

The basic principles of plant nutrition and soil management are well established and rather widely applicable. In addition, some of the major problems of supplying plant nutrients in tropical soils are known and partially solved. The economic, statistical, decision making, and agronomic tools needed to study food production efficiency are available for all advanced students in agricultural, and again, the facilities needed to adapt and demonstrate improved methods are modest. There does exist a major obstacle to adapting new agricultural technology in many poor countries and that is the economic, transportation, financial and educational infrastructure which is needed to sustain certain parts of new technology. Hence, the adaption of new agricultural technology must be carefully orchestrated with other technology to be as efficient and effective, overall, as is demanded in capital deficient countries.

In regions which are arid, the first technology usually considered is that of irrigation, closely followed by or simultaneously applied with improved varieties and soil amendment or fertilization. In ancient Egypt, we saw a civilization develop under natural irrigation by the Nile itself. Further northeast, we saw a civilization develop in which the hand of man played a more significant role. One continued; the other disappeared long ago. It disappeared because the soil chemical aspects of irrigation were not recognized and over almost a thousand years, the soil was destroyed by accumulation of the small amount of salt in the irrigation water. Babylonian tax records trace this decline, showing that initially, much wheat (a salt sensitive crop) was produced and taxed and very little barley (a salt tolerant crop) was produced. Before final collapse, the records showed mostly barley and little wheat, with the change having been gradual over the centuries[3].

Today, we are not likely to make the same mistake, because the salt problem is known and can be predicted. Also, procedures to prevent an undesirable build-up of salt in soils are available and used. However, an irrigation-based agricultural technology for crop production is most complex, because it requires all the other technologies as well. The benefits of bringing land under irrigation are short-lived unless engineering, fertilization, and improved variety technology are also applied. The demands on the infrastructure are also greater, but usually there is not much choice, e.g., northern Africa, southwestern Asian countries, and Chile and Peru. Here, however, irrigation technology is traditional and in harmony with the rest of the customs and the culture.

In concluding this part, something needs to be said of the so-called "green revolution" which has stimulated the imagination of many and brought new hope. Welsch and Sprague[4] had this to say in 1969: "We begin by recording our belief that the 'green revolution' in Southeast Asia has not been a technological revolution because it has failed to lay the basis for self-sustaining process of technological change, not only in grain production by in agriculture in general."

The authors implied that there was still a need for a back-up program of crop improvement, change, development, and diversification, and a program for early detection and control of insect and disease pests, to avoid the possibility of losing the single variety in one blow. This has happened many times, e.g., the potato in Ireland and the corn and small grain crops in the U.S. To me, it also means that the infrastructure to sustain the total potential still needs to be perfected in that region. The "green revolution" will be complete when these are achieved and the various cultures accommodate not only the new plants and production practices, but the other social innovations needed to sustain the new higher level of productivity in agriculture.

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TECHNOLOGY AND THE ARTS IN MODERN EUROPE

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TECHNOLOGY AND THE ARTS IN MODERN EUROPE

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In 1750, the Dijon Academy organized a questionnaire on the theme "Has the progress of art and science exerted any influence on the improvement of morals?" Only Jean Jacques Rousseau's answer to this won fame. Probably because his answer was unequivocally negative. In the age of the Great Encyclopedia to be known as the Age of Enlightenment, the worship of intellect, including inventiveness — an answer which negated all that and proclaimed a return to nature could not fail to be a sensational thunderclap. Indeed, questioning and "denouncing" generally accepted values always ensures greater fame and is more significant than endorsing them.

I should not like you to consider me, on the basis of what I have to say, a child of nature, which I certainly am not. I was born, brought up, and still live in a large European city, and my contacts with nature are somewhat rare. I have come here from a country which, in terms of technological development, is still far behind your country. Arriving at your beautiful campus from New York gives one the feeling of having reached a secure oasis. America generally is a country of startling contrasts, as I was able to realize during my visit here five years ago. Thinking about the United States brings to mind certain clichés: America is associated in our thinking with a technological Moloch, a terrific tempo of living, skyscrapers, and film stars with eyelashes a meter long. My country is, at present, after decades of underdevelopment, making up for its backwardness in relation to leading countries and is doing it with constantly increasing success. But for our progress we are paying an increasing price — the commercial cost associated with great investments.

I belong to the generation of those who are approaching their fifties. I was born in the age of the silent film and crystal radios with earphones. The five years of war and occupation cut my generation off from the problems of technical development, and the subsequent years isolated me from them by means of a device which was then generally known as the Iron Curtain. And suddenly, early in the sixties of our improbable epoch, technology burst in a mighty wave through all the curtains and walls. The film radically changed its image; television brutally invaded our flats violating the old English tenet — my home is my castle; the transistor radio became the curse of our streets and holiday resorts. The first drawback appeared — the pollution of air and water. Food poisoning emerged as a threat, though our food has not yet lost its flavor as often happens in your country. A friend of mine living permanently in New York often comes to Poland in the summer to gorge himself on our fresh strawberries which — I give you my word — do still differ in taste from apples and pears. Though the strawberries still retain their aroma, under the influence of technology our life began to change more and more, and with the transformation of life there appeared revolutionary changes in art.

I am not one easily to fall victim to neuroses. If I were, my experiences would have sufficed to send me to one of our asylums instead of to meet you here in Ames, Iowa. If I have retained some resistance, that is mainly because I have been able to create for myself a kind of private sanctuary. Of course, I participate — and quite actively —

in the life of my country, but I have a hideout to run to when the clamor of the modern world becomes unbearable. My house has thick walls and the room in which I work is not a low, soulless pill box. It has many of the technological conveniences of the twentieth century, but the character of its interior tends to reflect the nineteenth. When I travel, I try to stay in old hotels, steeped in tradition, and to eat in restaurants which have an intimate atmosphere. I hope you will not consider me some sort of mastodon if I confess that while making use of modern facilities I am not overattracted to them, and psychologically remain faithful to the climate in which my ancestors spent their lives — quite comfortably.

What I have just said applies also to art. That does not mean that as a creative worker and consumer I have anything against its modern forms. On the contrary. My generation hailed the invasion of modern art as a liberation after a longish period of nonsensical state meddling with the human soul. One speaks of "abstract art," but what we were fed in Stalinist times — that was "abstract." It was supposed to serve humanism because it presented man — in a book, a painting or a poster — in almost photographic fashion, casting his shadow, in the background, on a factory machine or a tractor. The photogenic machine or the handsome, smiling proletarian, with eyes fixed on some remote distance — to a vision of a future age of plenty — is how technology entered into art in the epoch of what was called socialist-realism.

So we accepted as a revelation a contorting or completely abstract art. We were prepared for it by the work of artists who in the inter-war period comprised the Polish avant-garde. Thus there is nothing surprising in our natural reaction to stories for good Sunday school children with a high-minded moral; it was with a euphoria, sometimes exaggerated, that we accepted unpleasant, cruel or even nihilistic works. Neatly rhymed congratulatory scrolls were supplanted by works in which the poetic image and even the word itself disintegrated. The wedding-cake buildings, decorated with innumerable gee-gaws, supposedly national in form and socialist in essence, persist as disturbing monuments to those days. Around them swarm truly modern structures which at first enraptured us but later became distressing in their soullessness.

It must be said openly and frankly that while the political life of our country after the great thaw of 1956 has suffered several convulsions, the revolution in art has already become irreversible. Marx said that structures which exist in tragic form sometimes reappear in the life of communities — but in the form of comedy. Those responsible for our culture and art must well have understood this, for no one has attempted to return to the immediate past, knowing that any such attempt would be laughed at. A general amnesty has been proclaimed as regards means of artistic expression, and as a result we find ourselves confronted by modern art with all its sublimities and obscurities.

It's obvious that radical changes in European art, the first signs of which appeared in the middle 19th century, and which in the 20th century developed rapidly, confronted not only recipients but also theoreticians and historians of art with numerous questions. Among recipients appeared the widespread phenomenon of taste not keeping pace with the development of art: before they had managed to assimilate the propositions of one artistic trend, a new one appeared in its place. So they felt more and more bewildered and more and more helpless. The tempo of changes in norms and criteria did – it is true – break down the old aesthetic habits, but only in those able to adapt to them. In most cases, the tempo proved too rapid for the possibilities of perception, and, breaking down nothing, confirmed the old ways. As a result, the polarization existing in European culture was widened and intensified: on the one hand, the new art became more and more exclusive, on the other, mass culture – its intelligibility associated with a serious lowering of ambitions and levels – extended itself.

However, this does not mean that modern art exercised an exclusively negative influence on recipients, drawing a line between itself and the possibilities of their understanding. Certain forms, at first exclusive, become in time subjected to dissemination among the masses; and the applied arts play the important role of mediator between the avant-grade and the recipients. To understand the degree to which the new plastic forms have penetrated into everyday life, I refer to the influence of abstract painting on the shapes of numerous articles of general use. The exclusive character or mass character of art is related in notions, describing the social situation in which art is placed, but not art itself. However, as often happens, the function identified itself with the object and exclusive art assumed in the eyes of numerous recipients (and not a few theoreticians) the form of a cultural eccentricity, to be either defended or condemned: defended in the name of pure beauty or the right of artists to unrestricted freedom; condemned in the name of the social functions of art. But in both cases the assumption is the same – that in the avant-garde there exists something of a state of emergency since its evolution does not proceed normally. Probably, the speed of changes occurring in modern art, without precedent in history, has contributed to the evolution of such an opinion. As Pierre Francastel rightly emphasizes, the differences between the painting of Veronese and Delacroix are less than those which separate Delacroix from Matisse; and, let us add further, that in the case of Matisse and Pollock they will seem still greater. The period of existence of individual artistic trends and styles was subjected to a sudden attenuation. In our age, decades bring more changes than centuries once did. But is that confined to art? Has art really found itself in an exceptional situation, the origins of which lie in the unusual if not simply perverse ideas of the artists?

This situation may be considered from the point of view of the internal evolution of art or, more broadly, by seeing in it the process occurring throughout the entire culture of our times. The first, imminent point of view, if not at the outset, then in the consequences, inevitably leads to considerations of an aesthetic nature. It will observe the changes of plans, criteria, evaluations, and measure the present art by the art of the past, and vice versa.

Limiting the history of art to the history of forms and aesthetic functions, we make out of it only a sustained dialogue of every present with every past, finally ascertaining what was, but not knowing why it was. With such an attitude to art, that which is the most inexplicable — the artist's talent — becomes the final explanation, and the history of art is consequently transformed into the history of artists. Yet the history of art is not simply the history of artists.

The second of the points of view presented here transcends art itself in order to understand it better. It is concerned not only with the attitude of art to its own past but with the attitude of art at every moment in history to the contemporary reality in which it existed. It will seek links connecting art with other occurrences and social processes. Such a point of view is characteristic of the sociology of art.

One may object against the aesthetic view that it examines works of art in isolation from their social functions; against the sociological view that considers only the social functions and loses sight of art itself. The traditional sociology of art limits its interests to something which it calls a social conditioning of art — that is, to those links between art and society which transcend the artistic and aesthetic functions of art.

In this situation, not being a historian of art, or a sociologist, but simply a writer — and at that a Polish writer, living in a specific, extraordinarily significant period in the development of a socialist community — it is better to withdraw from the front of theoretical discussion to a more satisfactory position of literary impressions on the margin of the theme. After all, to obtain grave answers to intelligent questions — if questions in general can be other than intelligent — my friends of Ames would turn to some extraordinarily learned professor and not to me. So I give you fair warning that I shall be talking about everything and nothing, rather on the pattern of a method which I discovered when I was still in school. Asked by a teacher during an examination what I knew about the Crusades — and I knew very little — I said that the best way to evaluate the Crusades was against the background of the overall atmosphere of the Middle Ages, and that nothing reflected that atmosphere better than Baroque. Needless to say, I was very well up in Baroque, and I was given a high mark before I began to compromise myself by having to reveal my ignorance concerning the Crusades. So much for probity — just by way of warning.

You will agree that in the countries of highly developed technology the process of transformation in art occurs naturally, and that on the principle of feedback technology shapes art, but art also influences the shape of technique. But in countries technologically less advanced, alongside the process of natural change there appears also the intervention of ready-made patterns on the principle of creative or merely mechanical imitation. And truth to tell, I do not suppose that the development of modern art in my country has been free from just such unoriginal components. Fashions, snobbery, seeking easy applause — is American art free from such sins? We know that modern art is a particularly absorptive field for mystifications of all kinds. It is not easy to draw a line between an interesting experiment in painting, music or poetry and simple rubbish. An author of theatre plays, offering gibberish to his audience, says with pride: "The rhythm of the new times is pulsing in my play. I am marching shoulder to shoulder with the epoch. To misunderstand me is comparable to the philistine whistling at the premiere of 'Hernani.'" Of course, no one wants to be the unspeakable philistine who failed to recognize the youthful genius of Victor Hugo — and so the graphomaniac-blackmailer goes scot free.

I am one of those who approve even the greatest eccentricities of modern art, provided that I don't suspect in them a desire to hoodwink me. And I do not see any method of distinguishing real art from a mystification, except one's own sensitivity and taste. So this is a field of creation particularly dependent on the sensitivity and taste of the recipient who if he is not simply a snob must have a certain artistic refinement.

I should like to add here a few warm words about the cool art produced by computers which, unlike people, can hardly be suspected of cunning. Computers compose music and plan choreography, write poetry, create graphic compositions and animated films. They are not subject to inspiration but in many domains of art are more efficient than human beings — and that arouses alarm. Science-fiction literature, an eminent European representative of which is a Pole, Stanislaw Iem, has for years fascinated us with a future world populated by robots. Our splendid writer of the older generation, Maria Dabrowska, wrote a dozen years ago in her essay "Technics and Humanism":

"One sleepless night, in the semi-conscious, semi-dreaming state known so well to insomniacs, a 'vision of the future' came to me. Electronic brains, robots and cybernetic machines had reached a high degree of development. Not only were they able to perform the most complicated mathematical calculations, but also to make new discoveries in physics and mathematics. Not only to translate competently from all languages, but also to form their own opinions in any language. They possessed a mechanism functioning like memory. They not only reacted to impulses of any kind but also understood the nature of their reactions and had control over them — in other words, they were in a way conscious of themselves. They became a new form of organized existence, functioning like living beings, though they had nothing in common with organic matter. The world of machines already knew how to jettison itself — that is, how to die and produce itself, or give birth. In this situation, the role of the human being was constantly diminished, men became unnecessary, even to operate the machines, since they were self-operating. Mankind's existence acquired traits of absurdity, though simultaneously the progress of science ensured for the people prosperity, health and exceptional longevity. But, having lost the sense of being indispensable, the human being slowly began to disappear — like an appendix of existence. What remained of degraded humanity was destroyed by the machines, already able to produce means of eliminating whatever was unnecessary for them, as men destroy weeds and pests in the environment. But in the mechanical memory of the technical world there persisted and was handed down to generations of rational machines a legend that they were the products of beings other than themselves. By degrees the legend concerning the human being who created them became transformed into a legend of a Creator of the universe, and hence also of the perfect world of machines. Part of the machines rejected this legend and tried to find out how the first machines came to be, hoping finally to reach the origins of mechanical existence."

It is noteworthy that in relating her oppressive dream, Maria Dabrowska seemed unaware of the famous play by the Czech writer Karel Capek, "RUR" — the letters stand for Rossums Universal Robots, the origin of that word robot — expressing another European intellectual's alarm at the terrifying progress of technology.

All fears and warnings apart, the fact has to be faced that technological progress is irreversible, as are the associated changes in art. We enthrone a Dickens or a Balzac, but it is difficult to imagine anybody writing today in the manner of Dickens or Balzac. The fascination with fashionable trends may pass, as with some of our painters who, after a lesson in the abstract, are returning to thematics. But that certainly doesn't mean a return to the old view of the world, because the world itself is already entirely different. And the most facile is to proclaim its approaching end.

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Pierre Francastel is probably right in saying that art, and only art, can discharge integrational functions in modern communities. Art is integrative because, transcending national frontiers, it becomes universal. The language of contemporary plastic artists holds sway over almost the entire globe. It is integrative also for the reason that, once grasped, it can reconcile an individual to the contemporary world through his aesthetic and cognitive experience.

One can hardly escape some reference here to the influence on the development of art exerted in my country by the media of mass information, above all — television. In Poland it is not a terrifying twelve-channel hydra, but although it has only two channels, it is undoubtedly a revolutionary factor. In spite of the fact that it is, as McLuhan requires, a cool medium of information. It belabors its spectator-listeners with words, music, plastic art and God knows what else, and gives rise to heated reactions. It reduces art, given as it is to ivory towers, to a utility role, brings it nearer to life according to concrete requirements. Modern plastic art, the impact of which on exhibition walls is often astonishing, becomes an interesting scenographic frame. Music which shocks in a concert hall is transformed into a fascinating background to a picture. Literature materializes and unravels itself. In this last domain there has emerged a new type of authorship, reacting quickly and efficiently to the social order, and that in no vulgar sense as was the case in the age of schematism. Unquestionably, television's greatest achievements have been in the domain of theatre which, by contrast with the film, was for several dozens of years considered an exclusive art.

The organization of Polish theatre life is different from the American. Our theatres are of the repertory type with settled groups of actors and producers. A television show gathers the producers and actors from several groups, as best suited to the performance, and this has enabled the scaling of astonishing artistic heights. The degree of popularisation of classical works, not to mention modern drama, is unprecedented. Serials devised at home and abroad are universally appreciated, and the popularity of TV personalities beats all records. A professor lecturing on the evolution of architecture and illustrating his words with his own, deft drawings becomes a star — on the same plane as an athlete who puts the shot or throws the hammer some stupendous distance. A writer who has found a language suitable for the television medium elbows out the masters enshrined by colleagues, poets and philosophers. Like it or not, these are irreversible processes, and it would be futile to shed tears over Art Pure and Undefiled by technology, art with a capital A.

By way of paradox modern technology simultaneously operates in two opposite directions. It creates mass media for mimeographing works of art — more perfect than ever known in history. It sets in motion information channels through which picture, sound, word and voice can reach millions within fractions of a second. Thus it has given the artist a chance unknown before — of having a global impact on the public all over the world. Technology is however sterile as a source of artistic inspiration. (This does not refer to its influences in helping in the creation of utility products which satisfy material needs.) If any branch of art is functional, if its products are the means of reaching determined material goals, then it finds a powerful ally in technology. Cities, houses, means of transportation, articles of everyday consumption can satisfy both elementary and aesthetic requirements.

Art has historically developed into something more than an instrument of evoking favorable impressions and emotions. Having stepped out of the sphere of magic and religion and become independent of them, it constitutes one of the defiances bid by man as an individual to omnitransition. In this eventually always lost battle, art has proved to be more effective than other tactics and methods. Hence it is above all an expression of individuality, outlasting the given individuality. The artist tries to impose on other people, also on other artists, his own way of experiencing the world by means peculiar to his natural aptitudes. If he succeeds too well, forms and subjects imposed by him grow to be common property; and the first inventors of a definite style, plastic or architectural shape, or convention disappear from the sight of future generations, who can then commune only with a certain petrified formation of works of art. This is how the history of fine arts is made: a number of respectable excavations; the living artist reduced to enriching the total cultural wealth by referring to tradition and by overcoming it.

Technology is the first and natural adversary of art at the source of its making, because it depersonalizes. Sociologists are well aware that the structural dynamics of social institutions should prevent the manifestation of its workers' individual traits. Inborn characterological features should yield to those required by the social functions which are performed. Mass Societies operate the more efficiently, the less peoples' individual characteristics reveal in their work. From some just as ideal or naive point of view it would probably be best if people at the top of governments as well as technicians, pilots, conductors, and salesclerks would be characterological models of perfection. This being impossible for very obvious reasons, the thing desirable in collective life is depersonalization, thanks to which benevolence, altruism, and kindness get to be one of the professional skills to be learned rather than the result of inborn inclinations.

Contemporary technology depersonalizes both the manufacturing of products or services and their final shape available on the market. Gradually dwindling is the number of jobs in which the personal artistry of an old, patient craftsman's ingenuity and talent are still necessary, and even of such jobs in which artistry might be revealed without infringing on collective proceedings. To have traffic flow on crowded highways, to produce an industrial product most rationally, to get the most handy and efficient service, technicians, salesclerks, workmen and managers should quit manifesting any and all nonaverage characteristics, both good and bad. The course of collective operations is quickest and most fluent when in transport, management, and services people behave in a way most like each other, imitating patterns of beyond-individual, above-personal efficiency which is the effect of precise technological experience.

The depersonalization of production now also embraces science where the era of the great lonely inventors is nearing its end. Though the authors of great discoveries still aren't anonymous, the individual inventive idea as soon as conceived becomes the object of "streamline processing," relayed by scientific information from continent to continent, which makes it difficult to tell what the first inventor has contributed from what other scientists added to the work which, in the meantime, has become a common work. Discoveries are more and more often born in large environments of strictly cooperating collectivities.

A depersonalization like that in the field of arts would in fact mean its liquidation. (I do not refer to "inferior art" meaning entertainment. Entertainment may develop in an atmosphere of triumphant technologies as it should in a sense be as efficient and impersonal as a car or aircraft.)

But in a technologized society, the artists are reduced to peculiar relics, a kind of anachronous phenomenon which may be indeed cultivated and even respected without however setting itself free of a certain ridiculousness. Where does this ridiculousness originate, floating over almost every artist of the technological century like Damocles' sword? First of all — from quantity as Stanislaw Lem says, "One Shakespeare is a magnificent phenomenon — ten Shakespeares are unusual, but when twenty thousand artists endowed with Shakespearean talent are alive, there is no single Shakespeare any more because the competition of a small group of artists for imposing an individual way of seeing the world on the public is something different from a just-as-funny-as-pitiful crowd at the inlet of the information channel system."

The artists' distrust and almost hostility toward technological acceleration show in the domains of art which fulfil cognitive functions apart from fulfilling emotional functions. I especially mean literature. Its delamination into entertainment and elite literature is especially obvious in the West. A literary experiment is a protest against the powers which decide on the development lines of society. The absence of literature in the field of discoveries and progress means their condemnation and, moreover, not always a silent one. Literature has gained historical greatness with its refusal to accept the evil of the human world, but its former adversaries — social systems and human nature shaped therein — were replaced by the evolutionary gradients of technology impersonal to an earlier unknown maximum. To criticize such gradients one has to use necessarily a language utterly strange to literature. The result of statistical and mass phenomena, they are the effect of material exploitation of the world we live in. And guilty of what is unwanted in it is the beyond-human sphere, sometimes to a greater extent than the sphere created by man. Literature has more interest in man than in the world; I am not denying that criticism, a lampoon on Nature, on the Universe, could be artistically fertile, but literature and its world-leading representatives deal with marginal problems. Social margins have been the object of European literature before, but there is a long way to go from a romantic to a psychopathological margin. Psychopathology often becomes a shelter for valuable talents because in its area technology is helpless.

Rather an idiot than a romantic fool is promoted to be the hero, as not the above-average but only the below-average returns to the artist the creative liberties he has lost in the technological epoch. Judgment, the elementary consciousness of the vainness of opposition, will keep the above-average individual in a mass society from attempts to trespass the tracks of collectivity; under circumstances like that, only a mentally deficient individual could act otherwise, i.e., manifest his interior liberty with irrational deeds.

Writers are in search of a contemporary hero, but if they succeed it is only their own, individual triumph and not the success of literature as a whole, because their search takes them to individuals and social groups which are either "independent of Technology" (mentally troubled individuals for instance) or constitutes an unintentional effect of the technological revolution (anti-social feelings spreading in some circles of the young generation).

Allow me to quote what the famous Spanish writer and thinker José Ortega y Gasset wrote about the dehumanization of art almost fifty years ago, which still remains the feeling of many European intellectuals:

"With amazing swiftness modern art has split up into a multitude of divergent directions. Nothing is easier than to stress the differences. But such an emphasis on the distinguishing and specific features would be pointless without a previous account of the common fund that in a varying and sometimes contradictory manner asserts itself throughout modern art. Did not Aristotle already observe that things differ in what they have in common? Because all bodies are colored we notice that they are differently colored. Species are nothing if not modifications of a genus, and we cannot understand them unless we realize that they draw, in their several ways, upon a common patrimony.

"I am little interested in special directions of modern art and, but for a few exceptions, even less in special works. Nor do I, for that matter, expect anybody to be particularly interested in my valuation of the new artistic produce. Writers who have nothing to convey but their praise or dispraise of works of art had better abstain from writing. They are unfit for this arduous task.

"The important thing is that there unquestionably exists in the world a new artistic sensibility. Over against the multiplicity of special directions and individual works, the new sensibility represents the generic fact and the source, as it were, from which the former spring.

This sensibility it is worthwhile to define. And when we seek to ascertain the most general and most characteristic feature of modern artistic production we come upon the tendency to dehumanize art. After what we have said above, this formula now acquires a tolerably precise meaning.

"Let us compare a painting in the new abstract style with one of, say, 1860. The simplest procedure will be to begin by setting against one another the objects they represent: a man perhaps, a house, or a mountain. It then appears that the artist of 1860 wanted nothing so much as to give to the objects in his picture the same looks and airs they possess outside it when they occur as parts of the 'lived' or 'human' reality. Apart from this he may have been animated by other more intricate aesthetic ambitions, but what interests us is that his first concern was with securing this likeness. Man, house, mountain are at once recognized, they are our good old friends... In modern paintings the opposite happens. It is not that the painter is bungling and fails to render the natural, natural = human thing because he deviates from it, but that these deviations point in a direction opposite to that which would lead to reality.

"Far from going more or less clumsily toward reality, the artist is seen going against it. He is brazenly set on deforming reality, shattering its human aspect, dehumanizing it. With the things represented on traditional paintings we could have imaginary intercourse. Many a young Englishman has fallen in love with Gioconda. With the objects of modern pictures no intercourse is possible. By divesting them of their aspect of 'lived' reality the artist has blown up the bridges and burned the ships that could have taken us back to our daily world. He leaves us locked up in an abstruse universe, surrounded by objects with which human dealings are inconceivable, and thus compels us to improvise other forms of intercourse completely distinct from our ordinary ways with things. We must invent unheard-of-gestures to fit those singular figures. This new way of life which presupposes the annulment of spontaneous life is precisely what we call understanding and enjoyment of art. Not that this life lacks sentiments and passions, but those sentiments and passions evidently belong to a flora other than that which covers the hills and dales of primary and human life."

To the young generation art is a thing of no consequence. The sentence is no sooner written than it frightens me since I am well aware of all the different connotations it implies. It is not that to any random person of our day art seems less important than it seemed to previous generations, but that the artist himself regards his art as a thing of no-consequence. But then again this does not accurately describe the situation. I do not mean to say that the artist makes light of his work and his profession; but they interest him precisely because they are of no transcendent importance. For a real understanding of what is happening let us compare the role art is playing today with the role it used to play thirty years ago and, in general, throughout the last century. Poetry and music then were activities of an enormous caliber. In view of the downfall of religion and the inevitable relativism of science, art was expected to take upon itself nothing less than the salvation of mankind. Art was important for two reasons: on account of its subjects which dealt with the profoundest problems of humanity, and on account of its own significance as a human pursuit from which the species derived its justification and dignity. It was a remarkable sight, the solemn air with which the great poet or the musical genius appeared before the masses — the air of a prophet and founder of religion, the majestic pose of a statesman responsible for the state of the world.

"The trend toward pure art betrays not arrogance, as is often thought, but modesty. Art that has rid itself of human pathos is a thing without consequence — just art with no other pretenses."

For some years we have observed important changes in European culture and the arts. Some people are even talking of the end of one period and the beginning of another — as we speak, for instance, about the beginning and the end of the Renaissance or the Enlightenment. That suggestion we find in certain works from which young protestors draw inspiration for their manifestos. It is true that since 1950 the rhythm of changes in culture and the arts began to accelerate. New trends and fashions then came into existence one after the other, which is generally explained by the process of industrialization — a new era incomparable to prior periods when technical forms of life remained unchanged for centuries.

In the last number of years, this fluctuation of trends — so typical for West European culture — is still increasing, and the tempo of it is modulated by the plastic arts and not by literature, as it was in the 19th century. For instance, in 1965 we could note in Paris about ten new propositions, which — in spite of their noisy originality — were able to interest the public for only a few weeks. Of course, we have to remember the commercial mechanism of such trends, but at any rate it is difficult to recognize any long-range perspectives in this period.

The latest trends to attain a degree of stabilization were Tashism and Pop-art in the plastic arts, the theater of the absurd, and the new novel or anti-novel in the field of literature. But today we already know that even those trends did not create an important link to further progress.

In 1970, for the first time in many years, we did not read about any new propositions in European art. This was a very strange phenomenon in a period of increasing prosperity – one which created a new influx of consumers of cultural goods and brought stagnation instead of development.

Another symptom, a rather alarming one, is the absence of leading works, of masterpieces. "Our epoch has not its masterpiece!" – this we read in the manifesto of French students during the famous events of 1968 in Paris. The word is used here a little ironically, as ammunition against their parents' generation which was educated by Proust, Mann or Gide. It seems as if the ancient concept of a masterpiece as a universal creation, including the problems of the epoch, had changed into some kind of a collective masterpiece, as, for example, jazz music from Armstrong to Miles Davis. Some critics are even against looking for exceptional works. They would rather consider contemporary European culture as a mass phenomenon with the accent on the word "mass," and not on the word "phenomenon."

There is a general feeling that a period in culture has come to an end. When abstract art began to rule over almost the whole world, some of the experts thought that this atomised form of art was the most consonant with the development of modern technology and would dominate for centuries. Now we hear a different opinion: that the coming epoch will have nothing in common with the present, which, I think, had its culmination before the First World War. Then, as a matter of fact, everything was created which was the starting point of our contemporary art — Cubism in painting, Shoenberg's dodecophony and Stravinski's experiments in music, Apollinaire's and Joyce's avant-garde in literature. Isn't Pop-art just a development of Marcel Duchamps' ideas from 1912? And after many years of exploitation and popularization, the elite forms of art came to our streets and homes, and the abstract geometry of Mondrian to women's skirts. Is this not a signal that this particular trend had reached its extremes?

Unlike abstract art, mass culture — another effect of the technological revolution — reached its apogee in the forties, and underwent the same process of development, "classic point," and degeneration. Films, jazz, music and detective novels are changing their original character. Motion pictures go through the "new wave" experiments; jazz begins to be symphonic; and thrillers change into psychological studies.

Perhaps the industrial epoch, which brought us all those changes in culture and art, is just now reaching its postindustrial phase, when not the machine but a new organization of life will be the center of economic, social and cultural progress? But what then can we think about the emerging nations, undergoing different processes of social evolution?

All this seems rather foggy, but one thing is certain — the crisis of abstract art and mass culture in their contemporary form does not mean the end of civilization and should not lead us to catastrophism. The new, audio-visual consumer of cultural goods needs and expects some new forms, which will not be just a mimeographing of ready patterns. And they will come, with or without technology.

Let us be patient, as happily we still have Bach, Stendhal, and Vermeer within our reach.

INDUCED INNOVATION AND AGRICULTURAL DEVELOPMENT

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STRATEGIES FOR AGRICULTURAL DEVELOPMENT

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During the 1960's a new consensus emerged to the effect that agricultural growth is critical (if not a precondition) for industrialization and general economic growth. Nevertheless, the process of agricultural growth itself has remained outside the concern of most development economists. Both technical change and institutional evolution have been treated as exogenous to their systems.

In this paper we review the evolution of thought, with respect to the process of agricultural development, that is implicit in much of the literature on agricultural and economic development; we elaborate the concept of induced technical and institutional innovation which we have employed in our own research on the agricultural development process; and we discuss the implications of the induced innovation perspective for the design of national and regional strategies for agricultural development.

Theories of Agricultural Development

A first step in any attempt to evolve a meaningful perspective on the process of agricultural development is to abandon the view of agriculture found in pre-modern or traditional societies as being essentially static[*]. Viewed in a historical context, the problem of agricultural development is not that of transforming a static agricultural sector into a modern dynamic sector, but of accelerating the rate of growth of agricultural output and productivity, consistent with the growth of other sectors of a modernizing economy. Similarly, a theory of agricultural development should provide insight into the dynamics of agricultural growth, into the changing sources of growth, in economies ranging from those in which output is growing at a rate of 1.0 percent or less to those in which agricultural output is growing at an annual rate of 4.0 percent or more.

It seems appropriate to characterize the literature on agricultural development into four general approaches: (a) Conservation, (b) urban industrial impact, (c) diffusion, and (d) high pay-off input models[†].

The Conservation Model The conservation model of agricultural development evolved from advances in crop and livestock husbandry associated with the English agricultural revolution[**] and concepts of soil exhaustion suggested by the early German soil scientists[*]. It was reinforced by the concept in the English classical school of economics of diminishing returns to labor and capital applied to land and labor[†]. The conservation model emphasized the evolution of a sequence of increasingly complex land and labor intensive cropping systems, the production and use of organic manures, and labor-intensive capital formation in the form of physical facilities to more effectively use land and water resources.

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[*] Even in pre-modern times, agriculture was characterized by the continuous, though relatively slow, development of agricultural tools, machines, plants, animals, and husbandry practices. The rate of development was influenced by long-run patterns of population growth and price fluctuations. For Western Europe see Slicher van Bath[1]. Comparable historical detail is not available for Asia. However, the view expressed here is consistent with the material presented by Ishikawa[2]. See also Boserup[3]; Geertz[4]; and Smith[5].

[†] These four models are characterized in much greater detail in Hayami and Ruttan[6], pp. 26-43.

[**] The "classical" description of the English agricultural revolution is in Lord Ernle[7]. In recent years agricultural historians have stressed the "evolutionary" in contrast to the "revolutionary" aspects of these changes. See, for example, Habakkuk[8]; Mingay[9]; and Timmer[10].

The Urban Industrial Impact Model The conservation model stands in sharp contrast to models in which geographic differences in the level and rate of economic development are primarily associated with urban-industrial development. Initially, the urban industrial impact model was formulated (by von Thünen) to explain geographic variations in the intensity of farming systems and in the productivity of labor in an industrializing society[**]. Later it was extended by T. W. Schultz[16, pp. 283-320] to explain the more effective performance of the factor and product markets linking the agricultural and nonagricultural sectors in regions characterized by rapid urban-industrial development. The model has been tested extensively in the United States[17-22], but has received only limited attention in the less developed world[23, pp. 311-78; 24, pp. 379-85].

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[*] See Usher[11]. Liebig attributed the decline of classical civilization to soil exhaustion. This view of the relationship between soil exhaustion and the decline of civilization has remained a persistent threat in the "underworld" of conservation literature. For a discussion of some of the doctrines about soils, see Kellogg[12].

[†] For a review see Barnett and Morse[13, pp. 101-47].

[**] See Dickinson[14] for a discussion of von Thünen economics and Nöu[15, pp. 184-230] for a history of the impact of von Thünen's work on economic thought.

The Diffusion Model The diffusion of better husbandry practices was a major source of productivity growth even in pre-modern societies[3, 11, 25, 26, pp. 113-34]. The diffusion approach to agricultural development rests on the empirical observation of substantial differences in land and labor productivity among farmers and regions. The route to agricultural development, in this view, is through a more effective dissemination of technical knowledge and a narrowing of the dispersion of productivity among farmers and among regions[*].

The diffusion model of agricultural development has provided the major intellectual foundation for much of the research and extension effort in farm management and production economics since the emergence, in the last half of the nineteenth century, of agricultural economics as a separate subdiscipline linking the agricultural sciences and economics. The developments that led to the establishment of active programs of farm management research and extension occurred at a time when experiment station research was making only a modest contribution to agricultural productivity growth[†]. A further contribution to the effective diffusion of known technology was provided by the research of rural sociologists on the diffusion process.

Models were developed emphasizing the relationship between diffusion rates and the personality characteristics and educational accomplishments of farm operators[**]. These insights into the dynamics of the diffusion process, when coupled with the observation of wide agricultural productivity gaps among developed and less-developed countries and a presumption of inefficient resource allocation among "irrational, tradition-bound" peasants, produced an extension bias in the choice of agricultural development strategy during the 1950's. The limitations of the diffusion model as a foundation for the design of agricultural development policies became increasingly apparent as technical assistance and community development programs, based explicitly or implicitly on the diffusion model, failed to generate either rapid modernization of traditional farms or rapid growth in agricultural output.

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[*] See, for example, the review of Bailey[27, pp. 130-31] and the specific case of Mosher[28].

[†] For a review of these developments in the United States see Taylor and Taylor[29, pp. 326-446].

[**] For a review of diffusion research by rural sociologists see Rogers[30; 31, pp. 111-35].

The High Pay-off Input Model The inadequacy of policies based on the conservation, urban-industrial impact, and diffusion models led, in the 1960's, to a new perspective that the key to transforming a traditional agricultural sector into a productive source of economic growth is investment designed[32] to make modern high pay-off inputs available to farmers in poor countries. Peasants in traditional agricultural systems were viewed as rational, efficient resource allocators. They remained poor because, in most poor countries, there were only limited technical and economic opportunities to which they could respond. The new high pay-off inputs, as identified by T. W. Schultz[32], can be classified into three categories: (a) The capacity of public and private sector research institutions to produce new technical knowledge; (b) the capacity of the industrial sector to develop, produce, and market new technical inputs; and (c) the capacity of farmers to acquire new knowledge and use new inputs effectively.

The enthusiasm with which the "high pay-off input" model has been accepted and translated into an economic doctrine has primarily been due to the success of efforts to develop new high-productivity grain varieties suitable for the tropics[33-35]. New high-yielding wheat and corn varieties were developed in Mexico, beginning in the 1950's, and new high-yielding rice varieties in the Philippines in the 1960's. These varieties were highly responsive to industrial inputs, such as fertilizer and other chemicals, and to more effective soil and water management. The high returns associated with the adaption of the new varieties and the associated technical inputs and management practices have led to rapid diffusion of the new varieties among farmers in several countries in Asia, Africa, and Latin America. The impact on farm production and income has been sufficiently dramatic to be heralded as a "green revolution." The significance of the high pay-off input model is that policies based on the model appear capable of generating a sufficiently high rate of agricultural growth to provide a basis for overall economic development consistent with modern population and income growth requirements.

As interpreted generally, the model is inclusive enough to embrace the central concepts of the conservation, urban-industrial impact, and diffusion models of agricultural development. The unique implications of the model for agricultural development policy are the emphasis placed on accelerating the process of development and propagation of new inputs or techniques through public investment in scientific research and education.

The high pay-off input model, as developed by Schultz[32], remains incomplete as a theory of agricultural development, however. Typically, education and research are public goods not traded through the market place. The mechanism by which resources are allocated among education, research, and other alternative public and private sector economic activities is not fully incorporated into the Schultz model*. The model does treat investment in research as the source of new high pay-off techniques. It does not explain how economic conditions induce the development and adaption of an efficient set of technologies for a particular society. Nor does it attempt to specify the processes by which factor and product price relationships induce investment in research in a particular direction.

An Induced Development Model

An attempt to develop a model of agricultural development in which technical change is treated as endogenous to the development process, rather than as an exogenous factor that operates independently of other development processes, must start with the recognition that there are multiple paths of technological development.

Alternative Paths of Technological Development There is clear evidence that technology can be developed to facilitate the substitution of relatively abundant (hence cheap) factors for relatively scarce (hence expensive) factors in the economy. The constraints imposed on agricultural development by an inelastic supply of land have, in economies such as Japan and Taiwan, been offset by the development of high yielding crop varieties designed to facilitate the substitution of fertilizer for land. The constraints imposed by an inelastic supply of labor, in the countries such as the United States, Canada, and Australia, have been offset by technical advances leading to the substitution of animal and mechanical power for labor. In both cases the new technology, embodied in new crop varieties, new equipment, or new production practices, may not always be substitutes for land or labor by themselves; rather they may serve as catalysts to facilitate the substitution of the relatively abundant factors (such as fertilizer or mineral fuels) for the relatively scarce factors. It seems reasonable, following Hicks, to call techniques designed to facilitate the substitution of other inputs for labor, "labor-saving," and ones designed to facilitate the substitution of other inputs for land, "land-saving." In agriculture, two kinds of technology generally correspond to this taxonomy: mechanical technology to "labor-saving" and biological and chemical technology to "land-saving."* The former is designed to facilitate the substitution of power and machinery for labor. Typically this involves the substitution of land for labor, because higher output per worker through mechanization usually requires a larger land area cultivated per worker. The latter, which we will hereafter identify as biological technology, is designed to facilitate the substitution of labor and/or industrial inputs for land. This may occur through increased recycling of soil fertility by more labor-intensive conservation systems; through use of chemical fertilizers; and through husbandry practices, management systems, and inputs (i.e., insecticides) which permit an optimum yield response.

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*In a more recent paper Schultz[36, pp. 90-120] stressed the need to direct research toward the analysis of this process.

Historically there has been a close association between advances in output per unit of land area and advances in biological technology; and between advances in output per worker and advances in mechanical technology. These historical differences have given rise to the cross-sectional differences in productivity and factor use illustrated in Figures 1 and 2†. The construction of an induced development model involves,

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*The distinction made here between "mechanical" and "biological" technology has also been employed by Heady[37]. It is similar to the distinction between "laboresque" and "landesque" capital employed by Sen[38]. In a more recent article Kaneda[39] employs the terms mechanical-engineering and biological-chemical.

†The productivity and factor use data presented in Figs. 1 and 2 have been analyzed in several earlier publications[6,40-43].

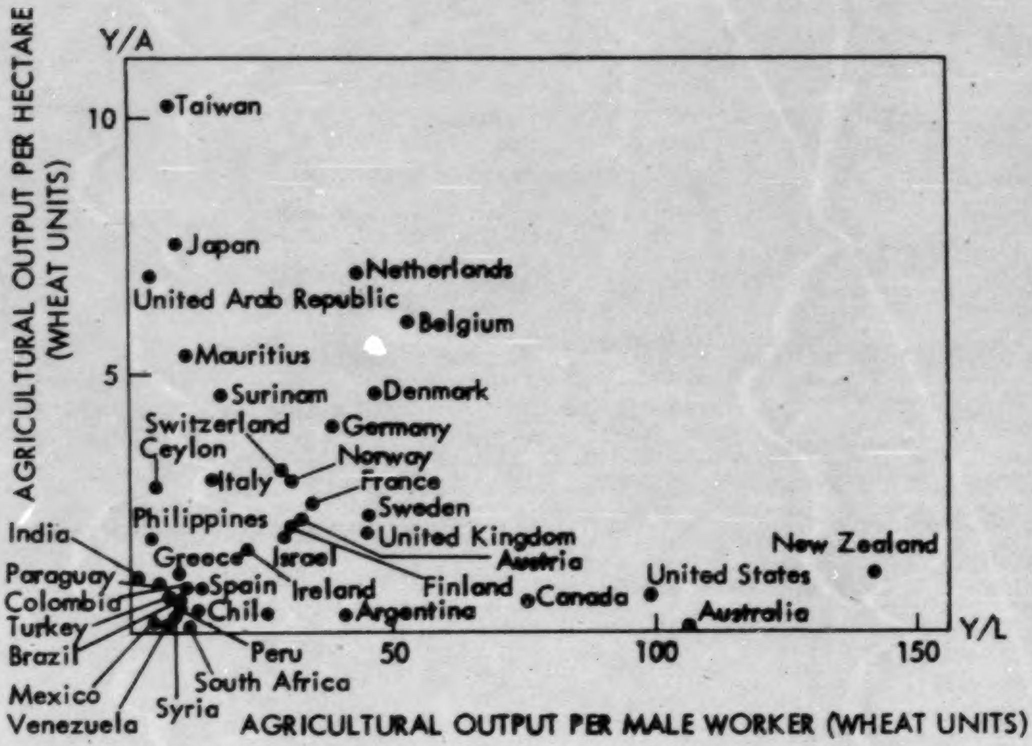

Figure 1. International comparison of agricultural output per male worker and per hectare of agricultural land. Output data are 1957 - 1962 averages; and labor and land data are of year closest to 1960.

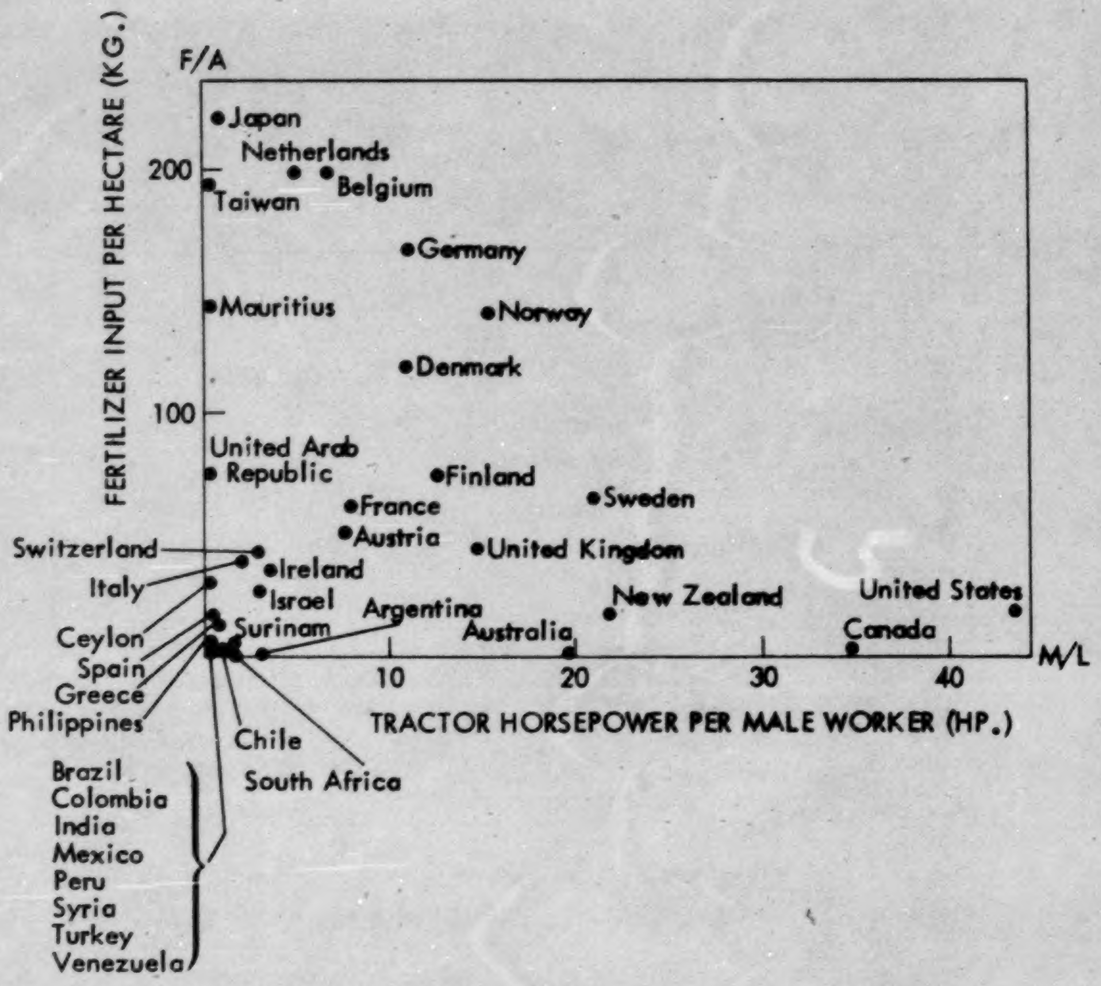

Figure 2. International comparison of tractor horsepower per male worker and of fertilizer input per hectare of agricultural land. Fertilizer data are 1957 - 1962 averages; and labor, land, and tractor data are of years closest to 1960.

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in addition to the elements considered in the models discussed earlier in this paper, an explanation of the mechanism by which a society chooses an optimum path of technological change in agriculture.

Induced Innovation in the Private Sector* There is a substantial body of literature on the "theory of induced innovation." Much of this literature focuses on the choice of available technology by the individual firm. There is, also, a substantial body of literature on how changes in factor prices over time or differences in factor prices among countries influence the nature of invention. This discussion has been conducted entirely within the framework of the theory of the firm. A major controversy has centered around the issue of the existence of a mechanism by which changes or differences in factor prices affect the inventive activity or the innovative behavior of firms.

It had generally been accepted, at least since the publication of Theory of Wages by Hicks[47, pp. 124-25] that changes or differences in the relative prices of factors of production could influence the direction of invention or innovation[*]. There have also been arguments raised by W. E. G. Salter[49, pp. 43-44] and others[48,50,51,26] against Hicks' theory of induced innovation. The arguments run somewhat as follows: Firms are motivated to save total cost for a given output; at competitive equilibrium, each factor is being paid its marginal value product; therefore, all factors are equally expensive to firms, hence; there is no incentive for competitive firms to search for techniques to save a particular factor.

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*The term "innovation" employed here embraces the entire range of processes resulting in the emergence of novelty in science, technology, industrial management, and economic organization rather than the narrow Schumpeterian definition. Schumpeter insisted that innovation was economically and sociologically distinct from invention and scientific discovery. He rejected the idea that innovation is dependent on invention or advances in science. This distinction has become increasingly artificial. See, for example, Solo[44], Ruttan[45], and Hohenberg[46]. Our view is similar to that of Hohenberg. He defines technical effort as the product of purposive resource using activity directed to the production of economically useful knowledge. "... technical effort is a necessary part of any firm activity, and is only in part separable from production itself. Traditionally it is part of the entrepreneur's job to provide knowledge to organize the factors of production in an optimum way, to adjust to market changes, and to seek improved methods. Technical effort is thus subsumed under entrepreneurship"[46, p. 61].

The difference between our perspective and Salter's is partly due to a difference in the definition of the production function. Salter defined the production function to embrace all possible designs conceivable by existing scientific knowledge and called the choice among these designs "factor substitution" instead of "technical change"[49, pp. 14-16]. Salter admits, however, that "relative factor prices are the nature of signal posts representing broad influences that determine the way technological knowledge is applied to production[30, p. 16]. If we accept Salter's definition, the allocation of resources to the development of high-yielding and fertilizer-responsive rice varieties adaptable to the ecological conditions of South and Southeast Asia, which are comparable to the improved varieties developed earlier in Japan and Taiwan, cannot be considered as a technical change. Rather, it is viewed as an application of existing technological knowledge (breeding techniques, plant-type concepts, etc.) to production.

Although we do not deny the case for Salter's definition, it is clearly not very useful in attempting to understand the process by which new technical alternatives become available. We regard technical change as any change in production coefficients resulting from the purposeful resource-using activity directed to the development of new knowledge embodied in designs, materials, or organizations. In terms of this definition, it is entirely rational for competitive firms to allocate funds to develop a technology which facilitates the substitution of increasingly less expensive factors for more expensive factors. Using the above definition, Ahmad[48] has shown that the Hicksian theory of market induced innovation can be defended with a rather reasonable assumption on the possibility of alternative innovations*.

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[*] See also the review of thought on this issue in Ahmad[48].

We illustrate the Ahmad argument with the aid of Figure 3. Suppose at a point of time a firm is operating at a competitive equilibrium, A or B, depending on the prevailing factor price ratio, p or m, for an isoquant, u_o, producing a given output; and this firm perceives multiple alternative innovations represented by isoquants, u_1, u_1', ..., producing the same output in such a way as to be enveloped by U, a concave curve innovation possibility curve or meta-production function which can be developed by the same amount of research expenditure. In order to minimize total cost for given output and given research expenditure, innovative efforts of this firm will be directed towards developing Y-saving technology (u_1) or X-saving technology (u_1') depending on the prevailing factor price ratio, p (parallel to PP) or m (parallel to MM and MM'). If a firm facing a price ratio, m, developed an X-saving technology (u_1') it can obtain an additional gain represented by the distance between M and M' compared with the case that developed a Y-saving technology (u_1). In this framework it is clear that, if X becomes more

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*See also discussions by Fellner[52] and Ahmad[53] and by Kennedy[54] and Ahmad[55].

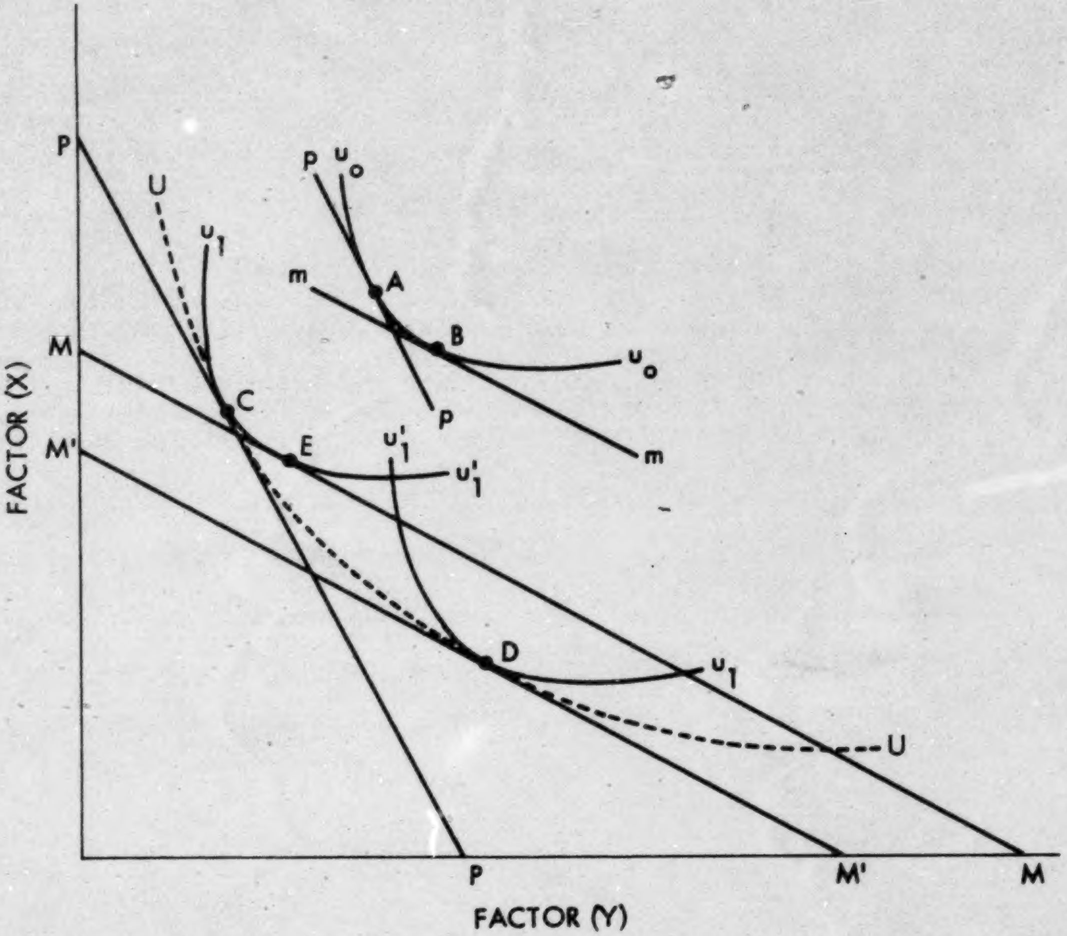

Figure 3. Factor prices and induced technical change.

expensive relative to Y over time in any economy the innovative efforts of entrepreneurs will be directed toward developing a more X-saving and Y-using technology compared to the contrary case. Also in a country in which X is more expensive relative to Y than in another country innovative efforts in the country will be more directed towards X-saving and Y-using than in the other country. In this formulation the expectation of relative price change, which is central to Fellner's theory of induced innovation, is not necessary, although expectations may work as a powerful reinforcing agent in directing technical effort*.

The rate of changing relative factor prices in inducing a continuous sequence of nonneutral biological and mechanical innovations along the iso-product surface of a meta-production function is further illustrated in Fig. 4. U represents the land-labor isoquant of the meta-production function which is the envelope of less elastic isoquants such as u_o and u_1 corresponding to different types of machinery or technology. A certain technology represented by u_o (e.g., reaper) is created when a price ratio, p_o, prevails a certain length of time. When the price ratio changes from p_o to p_1, another technology represented by u_1 (e.g., combine) is induced in the long run, which gives the minimum cost of production for p_o.

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*The above theory is based on the restrictive assumption that there exists a concave innovation possibility curve (U) which can be perceived by entrepreneurs. This is not as strong a restrictive assumption as it may first appear. The innovation possibility curve need not be of a smooth well-behaved shape as drawn in Fig. 3. The whole argument holds equally well for the case of two distinct alternatives. It seems reasonable to hypothesize that entrepreneurs can perceive alternative innovation possibilities for a given research and development expenditure through consultation with staff scientists and engineers or through the suggestions of inventors.

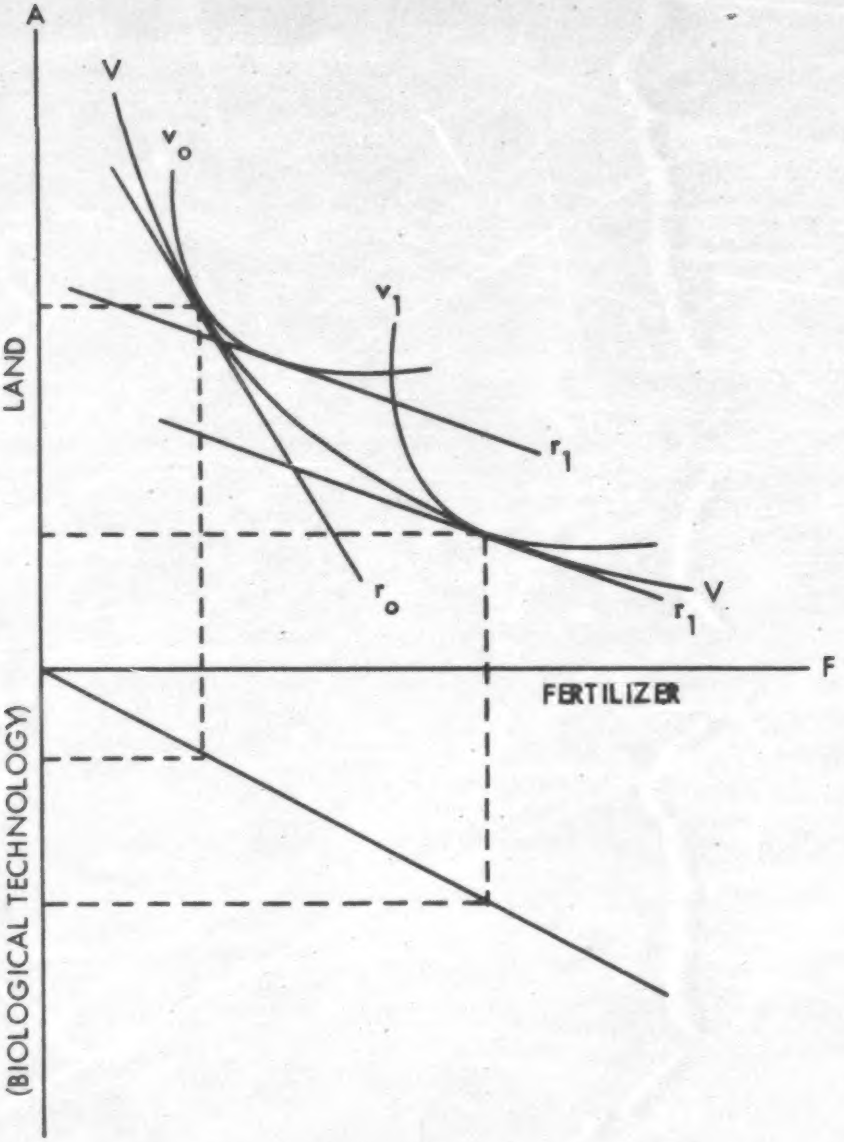

Figure 4a. Factor prices and induced mechanical and biological innovation.

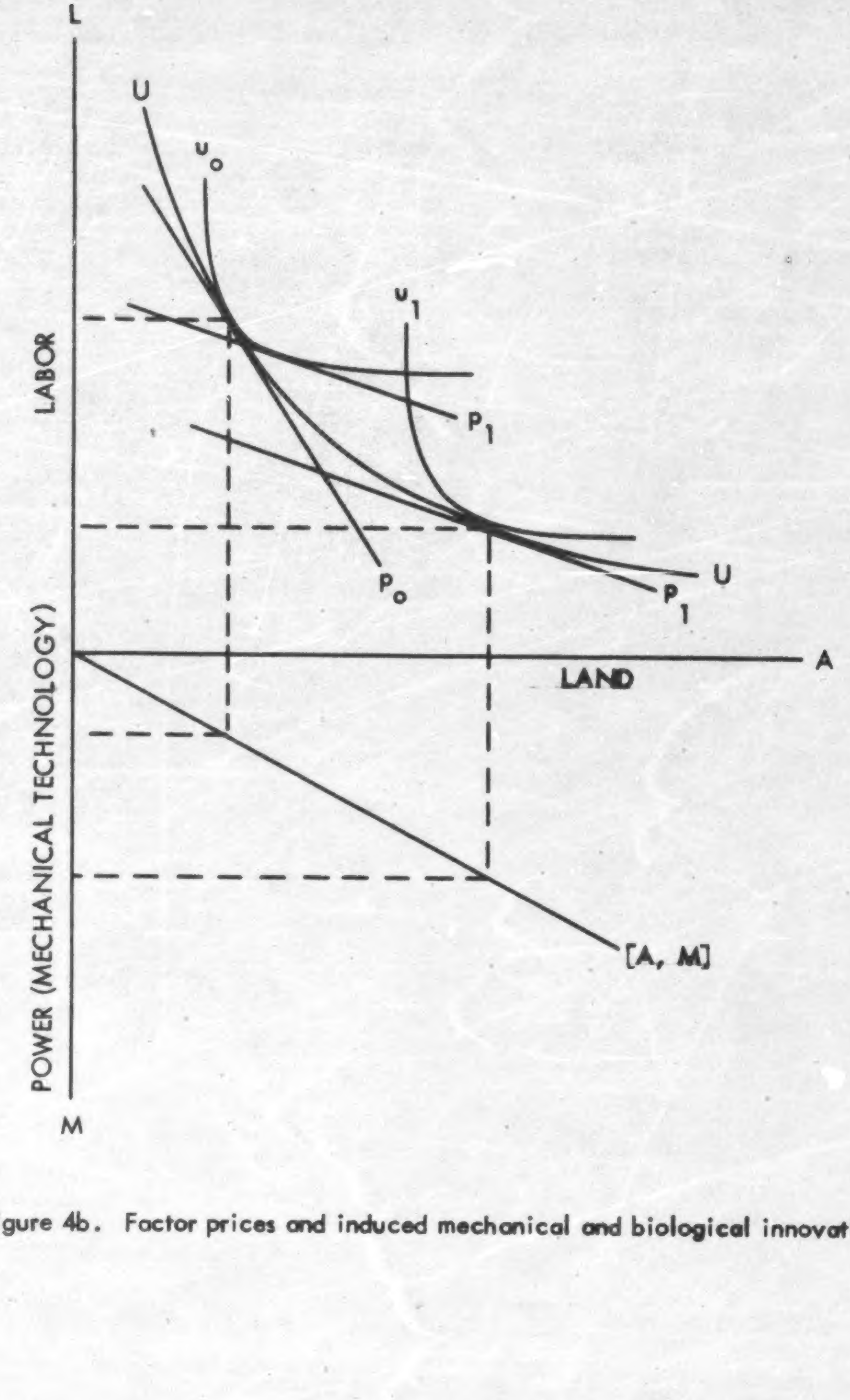

Figure 4b. Factor prices and induced mechanical and biological innovation.

The new technology represented by u_1, which enables enlargement of the area operated per worker, generally corresponds to higher intensity of power per worker. This implies the complementary relationship between land and power, which may be drawn as a line representing a certain combination of land and power [A, M]. In this simplified presentation, mechanical innovation is conceived as the substitution of a combination of land and power [A, M] for labor (L) in response to a change in wage relative to an index of labor and machinery prices, though, of course, in actual practice land and power are substitutable to some extent.

In the same context, the relation between the fertilizer-land price ratio and biological innovations represented by the development of crop varieties which are more responsible to application of fertilizers is illustrated in Figure 4. V represents the land-fertilizer isoquant of the meta-production function, which is the envelope of less elastic isoquants such as v_o and v_1 corresponding to varieties of different fertilizer responsiveness. A decline in the price of fertilizer relative to the price of land from r_o to r_1 creates an incentive for farmers to adopt crop varieties which are described by isoquants to the right of v_o and for private seed companies and public research institutions to develop and market such new fertilizer responsive varieties.

Induced Innovation in the Public Sector Innovative behavior in the public sector has largely been ignored in the literature on induced innovation. There is no theory of induced innovation in the public sector*. This is a particularly critical limitation in attempting to understand the process of scientific and technical innovation in agricultural development. In most countries which have been successful in achieving rapid rates of technical progress in agriculture, "socialization" of agricultural research has been deliberately employed as an instrument of modernization in agriculture.

Our view of the mechanism of "induced innovation" in the public sector agricultural research is similar to the Hicksian theory of induced innovation in the private sector. A major extension of the traditional argument is that we base the innovation inducement mechanism not only on the response to changes in the market prices of profit maximizing firms but also on the response by research scientists and administrators in public institutions to resource endowments and economic change.

We hypothesize that technical change is guided along an efficient path by price signals in the market, provided that the prices efficiently reflect changes in the demand and supply of products and factors and that there exists effective interaction among farmers, public research institutions, and private agricultural supply firms. If the demand for agricultural products increases, due to the growth in population and income, prices of the inputs for which the supply is inelastic will be raised relative to the prices of inputs for which the supply is elastic. Likewise, if the supply of particular inputs shifts to the right faster than others, the prices of these inputs will decline relative to the prices of other factors of production.

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*There is a growing literature on public research policy. See Nelson, Peck, and Kalachek[56]. The authors view public sector research activities as having risen from three considerations: (a) fields where the public interest is believed to transcend private incentives (as in health and aviation); (b) industries where the individual firm is too small to capture benefits from research (agriculture and housing); and (c) broadscale support for basic research and science education (pp. 151-211). For a review of thought with respect to resource allocation in agriculture see Fishel[57].

In consequence, technical innovations that save the factors characterized by an inelastic supply, or by slower shifts in supply, become relatively more profitable for agricultural producers. Farmers are induced, by shifts in relative prices, to search for technical alternatives which save the increasingly scarce factors of production. They press the public research institutions to develop the new technology and, also, demand that agricultural supply firms supply modern technical inputs which substitute for the more scarce factors. Perceptive scientists and science administrators respond by making available new technical possibilities and new inputs that enable farmers to profitably substitute the increasingly abundant factors for increasingly scarce factors, thereby guiding the demand of farmers for unit cost reduction in a socially optimum direction.

The dialectic interaction among farmers and research scientists and administrators is likely to be most effective when farmers are organized into politically effective local and regional farm "bureaus" or farmers associations. The response of the public sector research and extension programs to farmers' demand is likely to be greatest when the agricultural research system is highly decentralized, as in the United States. In the United States, for example, each of the state agricultural experiment stations has tended to view its function, at least in part, as to maintain the competitive position of agriculture in its state relative to agriculture in other states. Similarly, national policymakers may regard investment in agricultural research as an investment designed to maintain the country's competitive position in world markets or to improve the economic viability of the agricultural sector producing import-substitutes. Given effective farmer organizations and a mission- or client-oriented experiment station system, the competitive model of firm behavior, illustrated in Figures 3 and 4, can be usefully extended to explain the response of experiment station administrators and research scientists to economic opportunities.

In this public sector induced innovation model, the response of research scientists and administrators represents the critical link in the inducement mechanism. The model does not imply that it is necessary for individual scientists or research administrators in public institutions to consciously respond to market prices, or directly to farmers' demands for research results, in the selection of research objectives. They may, in fact, be motivated primarily by a drive for professional achievement and recognition[58]. Or they may, in the Rosenberg terminology, view themselves as responding to an "obvious and compelling need" to remove the constraints on growth of production or on factor supplies[*]. It is only necessary that there exists an effective incentive mechanism to reward the scientists or administrators, materially or by prestige, for their contributions to the solution of significant problems in the society*. Under these conditions, it seems reasonable to hypothesize that the scientists and administrators of public sector research programs do respond to the needs of society in an attempt to direct the results of their activity to public purpose. Furthermore, we hypothesize that secular changes in relative factor and product prices convey much of the information regarding the relative priorities which society places on the goals of research.

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[*] Rosenberg[59] has suggested a theory of induced technical change based on "obvious and compelling need" to overcome the constraints on growth instead of relative factor scarcity and factor relative prices. The Rosenberg model is consistent with the model suggested here, since his "obvious and compelling need" is reflected in the market through relative factor prices. C. Peter Timmer[60] has pointed out that in a linear programming sense the constraints which give rise to the "obvious and compelling need" for technical innovation in the Rosenberg model represent the "dual" of the factor prices used in our model. For further discussion of the relationships between Rosenberg's approach and that outlined in this section see Hayami and Ruttan[61].

The response in the public research sector is not limited to the field of applied science. Scientists trying to solve practical problems often consult with or ask cooperation of those working in more basic fields. If the basic scientists respond to the requests of the applied researchers, they are in effect responding to the needs of society. It is not uncommon that major breakthroughs in basic science are created through the process of solving the problems raised by research workers in the more applied fields*. It appears reasonable, therefore, to hypothesize, as a result of the interactions among the basic and applied sciences and the process by which public funds are allocated to research, that basic research tends to be directed also toward easing the limitations on agricultural production imposed by relatively scarce factors.

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*The issue of incentive is a major issue in many developing economies. In spite of limited scientific and technical manpower many countries have not succeeded in developing a system of economic and professional rewards that permits them to have access to, or make effective use of, the resources of scientific and technical manpower that are potentially available.

We do not argue, however, that technical change in agriculture is wholly of an induced character. There is a supply (an exogenous) dimension to the process as well as a demand (an endogenous) dimension. Technical change in agriculture reflects, in addition to the effects of resource endowments and growth in demand, the progress of general science and technology. Progress in general science (or scientific innovation) which lowers the "cost" of technical and entrepreneurial innovations may have influences on technical change in agriculture unrelated to changes in factor proportions and product demand[62,63]. Similarly, advances in science and technology in the developed countries, in response to their own resource endowments, may result in a bias in the innovation possibility curves facing the developing countries. Even in these cases, the rate of adoption and the impact on productivity of autonomous or exogenous changes in technology will be strongly influenced by the conditions of resource supply and product demand, as these forces are reflected through factor and product markets.

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*The symbiotic relationship between basic and applied research can be illustrated by the relation between work at the International Rice Research Institute in (a) genetics and plant physiology and (b) plant breeding. The geneticist and the physiologist are involved in research designed to advance understanding of the physiological processes by which plant nutrients are transformed into grain yield and of the genetic mechanisms or processes involved in the transmission from parents to progenies of the physiological characteristics of the rice plant which affect grain yield. The rice breeders utilize this knowledge from genetics and plant physiology in the design of crosses and the selection of plants with the desired growth characteristics, agronomic traits, and nutritional value. The work in plant physiology and genetics is responsive to the need of the plant breeder for advances in knowledge related to the mission of breeding more productive varieties of rice.

Thus, the classical problem of resource allocation, which was rejected as an adequate basis for agricultural productivity and output growth in the high pay-off input model, is, in this context, treated as central to the agricultural development process. Under conditions of static technology, improvements in resource allocation represent a weak source of economic growth. The efficient allocation of resources to open up new sources of growth is, however, essential to the agricultural development process.

Institutional Innovation Extension of the theory of "induced innovation" to explain the behavior of public research institutions represents an essential link in the construction of a theory of induced development. In the induced development model, advances in mechanical and biological technology respond to changing relative prices of factors, and to changes in the prices of factors relative to products, to ease the constraints on growth imposed by inelastic supplies of land or labor. Neither this process, nor its impact, is confined to the agricultural sector. Changes in relative prices in any sector of the economy act to induce innovative activity, not only by private producers but also by scientists in public institutions, in order to reduce the constraints imposed by those factors of production which are relatively scarce.

We further hypothesize that the institutions that govern the use of technology or the "mode" of production can also be induced to change in order to enable both individuals and society to take fuller advantage of new technical opportunities under favorable market conditions[*]. The Second Enclosure Movement in England represents a classical illustration. The issuance of the Enclosure Bill facilitated the conversion of communal pasture and farmland into single, private farm units, thus encouraging the introduction of an integrated crop-livestock "new husbandry" system. The Enclosure Acts can be viewed as an institutional innovation designed to exploit the new technical opportunities opened up by innovations in crop rotation, utilizing the new fodder crops (turnip and clover), in response to the rising food prices.

A major source of institutional change has been an effort by society to internalize the benefits of innovative activity to provide economic incentives for productivity increase. In some cases, institutional innovations have involved the reorganization of property rights, in order to internalize the higher income streams resulting from the innovations. The modernization of land tenure relationships, involving a shift from share tenure to lease tenure and owner-operator systems of cultivation in much of western agriculture, can be explained, in part, as a shift in property rights designed to internalize the gains of entrepreneurial innovation by individual farmers[†].

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[*] At this point we share the Marxian perspective on the relationship between technological change and institutional development, though we do not accept the Marxian perspective regarding the monolithic sequences of evolution based on clear-cut class conflicts. For two recent attempts to develop broad historical generalizations regarding the relation between institutions and economic forces, see Hicks[64] and North and Thomas[65].

[†] For additional examples see Davis and North[66].

Where internalization of the gains of innovative activity are more difficult to achieve, institutional innovations involving public sector activity become essential. The socialization of much of agricultural research, particularly the research leading to advances in biological technology, represents an example of a public sector institutional innovation designed to realize for society the potential gains from advances in agricultural technology. This institutional innovation originated in Germany and was transplanted and applied on a larger scale in the United States and Japan.

Both Schultz[67] and Ohkawa[68] have argued that institutional reform is appropriately viewed as a response to the new opportunities for the productive use of resources opened up by advances in technology*. Our view, and the view of Ohkawa and Schultz, reduces to the hypothesis that institutional innovations occur because it appears profitable for individuals or groups in society to undertake the costs. It is unlikely that institutional change will prove viable unless the benefits to society exceed the cost. Changes in market prices and technological opportunities introduce disequilibrium in existing institutional arrangements by creating profitable new opportunities for the institutional innovations.

Profitable opportunities, however, do not necessarily lead to immediate institutional innovations. Usually the gains and losses from technical and institutional change are not distributed neutrally. There are, typically, vested interests which stand to lose and which oppose change. There are limits on the extent to which group behavior can be mobilized to achieve common or group interests[69]. The process of transforming institutions in response to technical and economic opportunities generally involves time lags, social and political stress, and, in some cases, disruption of social and political order. Economic growth ultimately depends on the flexibility and efficiency of society in transforming itself in response to technical and economic opportunities.

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*Also see North and Thomas[65].

Agricultural Development Strategy

The induced innovation model outlined above does not possess formal elegance. It is partial, in that it is primarily concerned with production and productivity. Yet it has added significantly to our power to interpret the process of agricultural development.

Research which we have reported elsewhere indicates that the enormous changes in factor proportions which have occurred in the process of agricultural growth in the United States and Japan are explainable very largely in terms of changes in factor price ratios[6,70]. When we relate the results of the statistical analysis to historical knowledge of advances in agricultural technology, we conclude that the observed changes in input mixes have occurred as the result of a process of dynamic factor substitution along a meta-production function, associated with changes in the production surface, induced primarily by changes in relative factor prices. Preliminary results of the analysis of historical patterns of technical change in German agriculture (by Adolph Weber); in Denmark, Great Britain and France (by William Wade); and in Argentina (by Alain de Janvry) add additional support to the utility of the induced innovation model in interpreting historical patterns of technological change and agricultural development.

The question remains, however, as to whether the induced development model represents a useful guide to modern agricultural development strategy? In responding to this concern two issues seem particularly relevant.

First, we would like to make it perfectly clear that in our view the induced development model, in which technical and institutional change is treated as endogenous to the development process, does not imply that agricultural development can be left to an "invisible hand" that directs either technology, or the total development process, along an "efficient" path determined by "original" resource endowments.

We do argue that the policies which a country adopts with respect to the allocation of resources to technical and institutional innovation; to the capacity to produce technical inputs for agriculture; to the linkages between the agricultural and industrial sectors in factor and product markets; and to the organization of the crop and livestock production sectors must be consistent with national (or regional) resource endowments if they are to lead to an "efficient" growth path. Conversely, failure to achieve such consistency can sharply increase the real costs, or abort the possibility, of achieving sustained economic growth in the agricultural sector.

If the induced development model is valid — if alternative paths of technical change and productivity growth are available to developing countries — the issue of how to organize and manage the development and allocation of scientific and technical resources becomes the single most critical factor in the agricultural development process. It is not sufficient to simply build new agricultural research stations. In many developing countries existing research facilities are not employed at full capacity because they are staffed with research workers with limited scientific and technical training; because of inadequate financial, logistical, and administrative support; because of isolation from the main currents of scientific and technical innovation; and because of failure to develop a research strategy which relates research activity to the potential economic value of the new knowledge it is designed to generate.

The appropriate allocation of effort between the public and the private sector also becomes of major significance in view of the extension of the induced development model to incorporate innovative activity in the public sector. It is clear that during the early stages of development the socialization of much of biological research in agriculture is essential if the potential gains from biological technology are to be realized. The potential gains from public sector investment in other areas of the institutional infrastructure which are characterized by substantial spillover effects are also large. This includes the modernization of the marketing system through the establishment of the information and communication linkages necessary for the efficient functioning of factor and product markets*.

In most developing countries the market systems are relatively underdeveloped, both technically and institutionally. A major challenge facing these countries in their planning is the development of a well articulated marketing system capable of accurately reflecting the effects of changes in supply, demand, and production relationships. An important element in the development of a more efficient marketing system is the removal of the rigidities and distortions resulting from government policy itself — including the maintenance of overvalued currencies, artificially low rates of interest, and unfavorable factor and product price policies for agriculture[72].

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*Hayami and Peterson[71] show that the returns to investment in improvements in market information is comparable to the returns that have been estimated for high pay-off research areas such as hybrid corn and poultry.

The criteria specified above for public sector investment or intervention also implies a continuous reallocation of functions among public and private sector institutions. As institutions are developed which are capable of internalizing a larger share of the gains of innovative activity, it may become possible to transfer activities, the production of new crop varieties for example, to the private sector and to reallocate public resources to other high pay-off areas. Many governments are presently devoting substantial resources to areas of relatively low productivity — in efforts to reform the organization of credit and product markets for example — while failing to invest the resources necessary to produce accurate and timely market information, establish meaningful market grades and standards, and establish the physical infrastructure necessary to induce technical and logistical efficiency in the performance of marketing functions[73].

A second issue is whether, under modern conditions, the forces associated with the international transfer of agricultural technology are so dominant as to vitiate the induced development model as a guide to agricultural development strategy. It might be argued, for example, that the dominance of the developed countries in science and technology raises the cost, or even precludes the possibility of the invention of location specific biological and mechanical technologies adapted to the resource endowments of a particular country or region.

This argument has been made primarily with reference to diffusion of mechanical technology from the developed to the developing countries. It is argued that the pattern of organization of agricultural production adopted by the more developed countries — dominated by large-scale mechanized systems of production, in both the socialist and nonsocialist economics — precludes an effective role for an agricultural system based on small-scale commercial or semi-commercial farm production units[74,75*].

We find this argument unconvincing. Rapid diffusion of imported mechanical technology, in areas characterized by small farms and low wages in agriculture, tends to be induced by inefficient price, exchange rate, and credit policies which substantially distort the relative costs of mechanical power relative to labor and other material inputs. Islam reports, for example, that as a result of such policies the real cost of tractors in West Pakistan was substantially below the cost in the United States[76]. The preliminary findings of work by John Sanders in Latin America also stresses the role of market distortions in inducing mechanization.

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[*] Owen argues that differentiation of a rural commercial sector from the rural subsistence sector is the first step toward development of relevant agricultural development policies. The "optimum sized commercial farms will comprise the maximum amount of land that can be farmed at a profit by an appropriate set of labor where the latter uses a relatively advanced level of technology for the particular farming area....the optimum sized subsistence farm plot is one that comprises the minimum amount of land that is necessary to assure to the household concerned the minimum acceptable standard of subsistence living...."[74, p. 107].

We are also impressed by the history of agricultural mechanization in Japan and more recently in Taiwan. Both countries have been relatively successful in following a strategy of mechanical innovation designed to adopt the size of the tractor and other farm machinery rather than modifying the size of the agricultural production unit to make it compatible with the size of imported machinery*.

We do insist that failure to effectively institutionalize public sector agricultural research can result in serious distortion of the pattern of technological change and resource use. The homogeneity of agricultural products and the relatively small size of the farm firm, even in the western and socialist economics of the West, make it difficult for the individual agricultural producer to either bear the research costs or capture a significant share of the gains from scientific or technological innovation. Mechanical technology has, however, been much more responsive than biological technology to the inducement mechanism as it operates in the private sector. In biological technology, typified by the breeding of new plant varieties or the improvement of cultural practices, it is difficult for the innovating firm to capture more than a small share of the increased income stream resulting from the innovation.

Failure to balance the effectiveness of the private sector in responding to inducements for advances in mechanical technology, and in those areas of biological technology in which advances in knowledge can be embodied in proprietary products, with institutional innovation capable of providing an equally effective response to inducements for advances in biological technology, leads to a bias in the productivity growth path that is inconsistent with relative factor endowments. It seems reasonable to hypothesize that failure to invest in public sector experiment stations capacity is one of the factors responsible in some developing countries for the unbalanced adoption of mechanical, relative to biological, technology. Failure to develop adequate public sector research institutions has also been partially responsible, in some countries, for the almost exclusive concentration of research expenditures on the plantation crops and for concentration on the production of certain export crops, such as sugar and bananas, in the plantation sector.

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*This development is reviewed in Hayami and Ruttan[6].

The perspective outlined in this paper can be summarized as follows: an essential condition for success in achieving sustained growth in agricultural productivity is the capacity to generate an ecologically adapted and economically viable agricultural technology in each country or development region. Successful achievement of continued productivity growth overtime involves a dynamic process of adjustment to original resource endowments and to resource accumulation during the process of historical development. It also involves an adaptive response on the part of cultural, political, and economic institutions, in order to realize the growth potential opened up by new technical alternatives. The "induced development model" attempts to make more explicit the process by which technical and institutional changes are induced through the responses of farmers, agribusiness entrepreneurs, scientists, and public administrators to resource endowments and to changes in the supply and demand of factors and products.

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